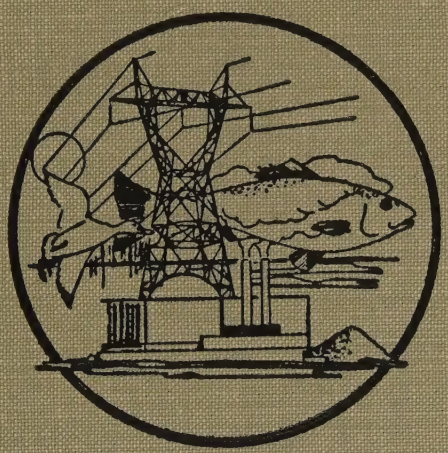
Biological Services Program

DEVELOPMENT OF FISHES OF THE MID-ATLANTIC BIGHT

AN ATLAS OF EGG, LARVAL AND JUVENILE STAGES

VOLUME IV

CARANGIDAE THROUGH EPHIPPIDAE



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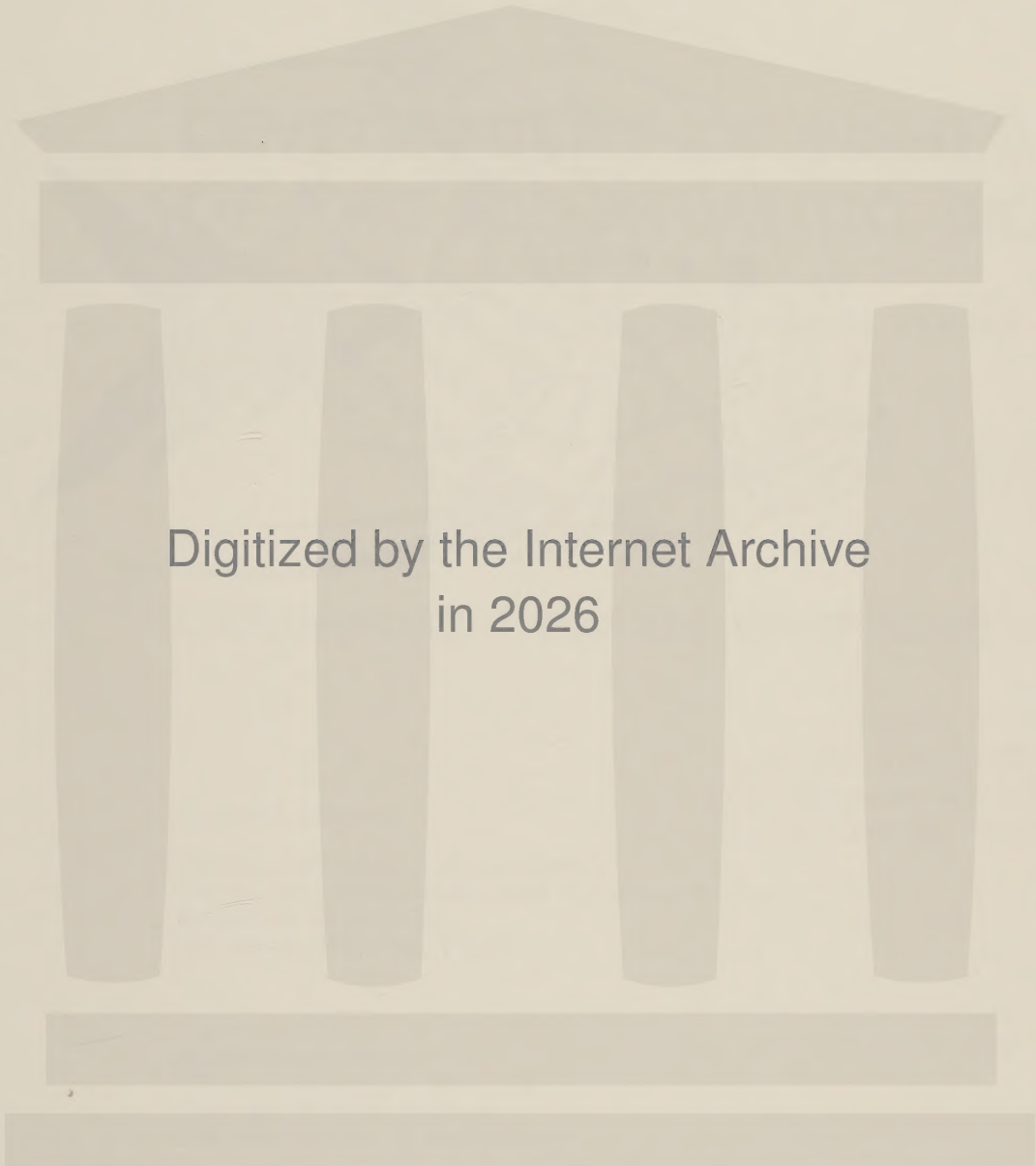

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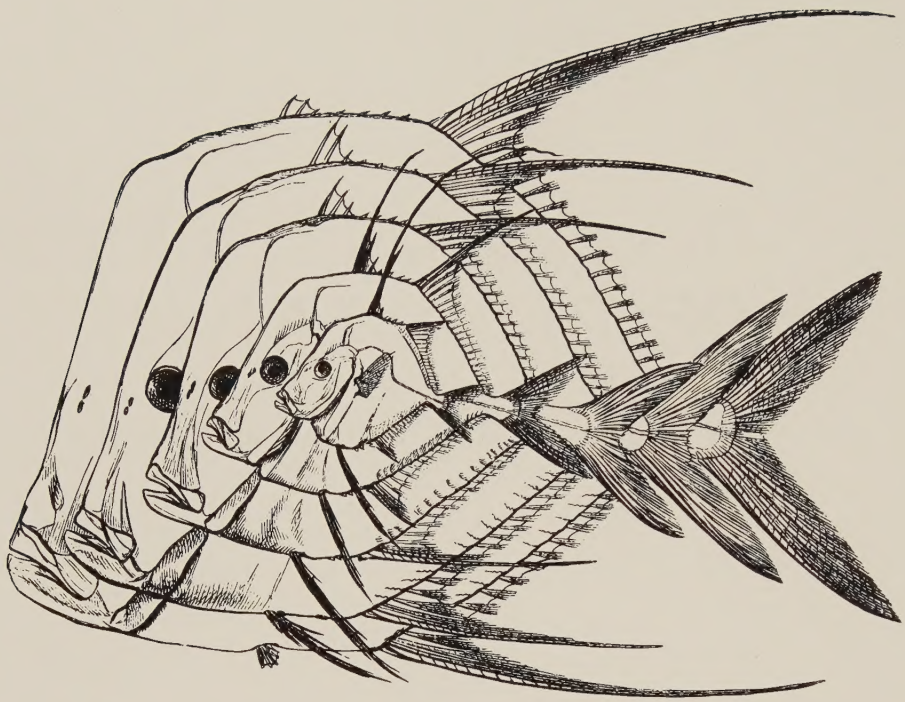

Frontispiece: Five juvenile *Selene vomer* (Linnaeus) showing changes in proportions and shape related to growth. (*Lütken, C.F., 1880: 547*).

Biological Services Program

FWS/OBS-78/12
January 1978

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CARANGIDAE THROUGH EPHIPPIDAE

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Performed for
Power Plant Project
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior

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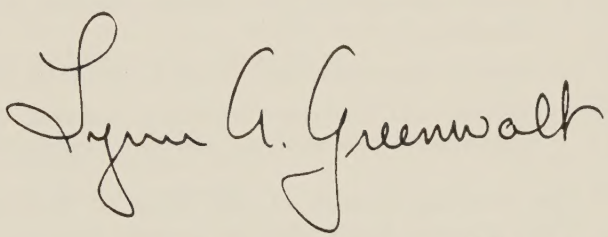
FOREWORD

The demand for electric energy often creates conflicts with the desire to preserve and protect the Nation's fish and wildlife resources. This is particularly true when the use of water for power plants is considered. Power plants require large volumes of water from rivers, lakes, reservoirs, and estuaries. Withdrawal of water for cooling purposes causes the loss of fish eggs, larvae, and juveniles through impingement or entrainment. The discharge of water causes thermal and chemical pollution, and can cause alteration of stream flow patterns and the disruption of the thermal and dissolved oxygen stratification in those water bodies.

The biological consequences of water use by power plants depend upon the species of organisms involved, the mechanical and physiological stresses on the organisms, and the ecological role of the organisms. To assess the impacts of power plants and other habitat modifications on fish populations, it is necessary to identify fish eggs, larvae, and juveniles of different species. However, up to now, descriptions of the developmental stages of fishes have been scattered throughout a large number of sources.

The *Development of Fishes of the Mid-Atlantic Bight* is a reference which compiles descriptions of the egg, larval, and juvenile stages of over 300 fish species, and includes dichotomous keys useful for identifying species. Descriptions of spawning migrations and life habits of adult fishes, their geographic range and distribution, and movements of fish at all life stages are also included.

With this kind of baseline taxonomic information, biologists will be able to assess the management implications of power plant siting and other habitat modifications on aquatic populations and provide information to decision makers. We believe these books are a major step in providing the type of information necessary to incorporate environmental considerations into resource development decisions.



Director, U.S. Fish and Wildlife Service

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues which impact fish and wildlife resources and their supporting ecosystems. The mission of the Program is as follows:

1. To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
2. To gather, analyze, and present information that will aid decision makers in the identification and resolution of problems associated with major land and water use changes.
3. To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decision making process to prevent or minimize the impact of development on fish and wildlife. Biological Services research activities and technical assistance services are based on an analysis of the issues, the decision makers involved and their information needs, and an evaluation of the state of the art to identify information gaps and determine priorities. This is a strategy to assure that the products produced and disseminated will be timely and useful.

Biological Services projects have been initiated in the following areas:

- Coal extraction and conversion
- Power plants
- Geothermal, mineral, and oil shale development
- Water resource analysis, including stream alterations and western water allocation
- Coastal ecosystems and Outer Continental Shelf development
- Systems and inventory, including National Wetlands Inventory, habitat classification and analysis, and information transfer.

The Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams which provide the Program's central scientific and technical expertise and who arrange for contracting Biological Services studies with States, universities, consulting firms, and others; regional staff who provide a link to problems at the operating level; and staff at certain Fish and Wildlife Service research facilities who conduct in-house research studies.

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GENERAL INTRODUCTION

As noted by Mansueti and Hardy (1967) in the first edition of Volume I of this series, the early developmental stages of most fishes are either poorly known or completely unknown. Despite the fundamental importance of this knowledge to many aspects of fishery biology and ichthyology, this situation still persists.

OBJECTIVES

The primary purpose of this series is to synthesize the world literature on fishes occurring in the Mid-Atlantic Bight of the United States. The successful accomplishment of this goal serves a number of useful functions, among which are greater ease in identifying young fishes and fish eggs, the systematization of information gaps, and the stimulation of studies in areas where such gaps have been clearly demonstrated. Although some original data have been included in this series, time constraints have kept this to a minimum, primary efforts having been directed toward a comprehensive review of existing literature.

FORMAT

The geographical area considered extends from the northern boundary of New Jersey to the southern boundary of Virginia from tidal freshwater out to the 100 fathom contour (see fig. 1).

Data have been presented on 321 species. Mansueti and Hardy (1967) arranged the species in Volume I in the sequence used by the American Fisheries Society (1960). Although disagreements exist with this arrangement as a phylogenetic sequence it is used here to order the species and families in this series so that the revised Volume I will remain intact. In some cases recent systematic revisions have demanded realignment at familial levels or the updating of generic and specific names.

The series is presented in six volumes as follows: Volume I, Acipenseridae through Ictaluridae, 50 species; Volume II, Anguillidae through Syngnathidae, 48 species; Volume III, Aphredoderidae through Rachycentridae, 52 species; Volume IV, Carangidae through Ephippidae, 52 species; Volume V, Chaetodontidae through Ophidiidae, 52 species; and Volume VI, Stromateidae through Ogcocephalidae, 67 species.

Species accounts are arranged alphabetically within family groupings. Each species account is divided into the following major divisions:

Adults—meristics, morphometrics and general description.

Distribution and ecology—range, habitat and movements of adults, larvae, and juveniles.

Spawning—description of season, location, conditions of spawning, and fecundity.

Eggs—description of ripe ovarian, unfertilized or fertilized eggs.

Egg development—developmental sequences, physical limiting factors and incubation times.

Yolk-sac larvae—size range, morphology, development and pigmentation.

Larvae—size range, morphology, development and pigmentation.

Prejuveniles (not recognized in all volumes)—size range, morphology, development and pigmentation.

Juveniles—size range, morphology, development and pigmentation.

Growth (not given in all volumes)—average and/or representative growth rates, especially preadult growth.

Age and size at maturity—average age and size at maturity plus variation if these data are available.

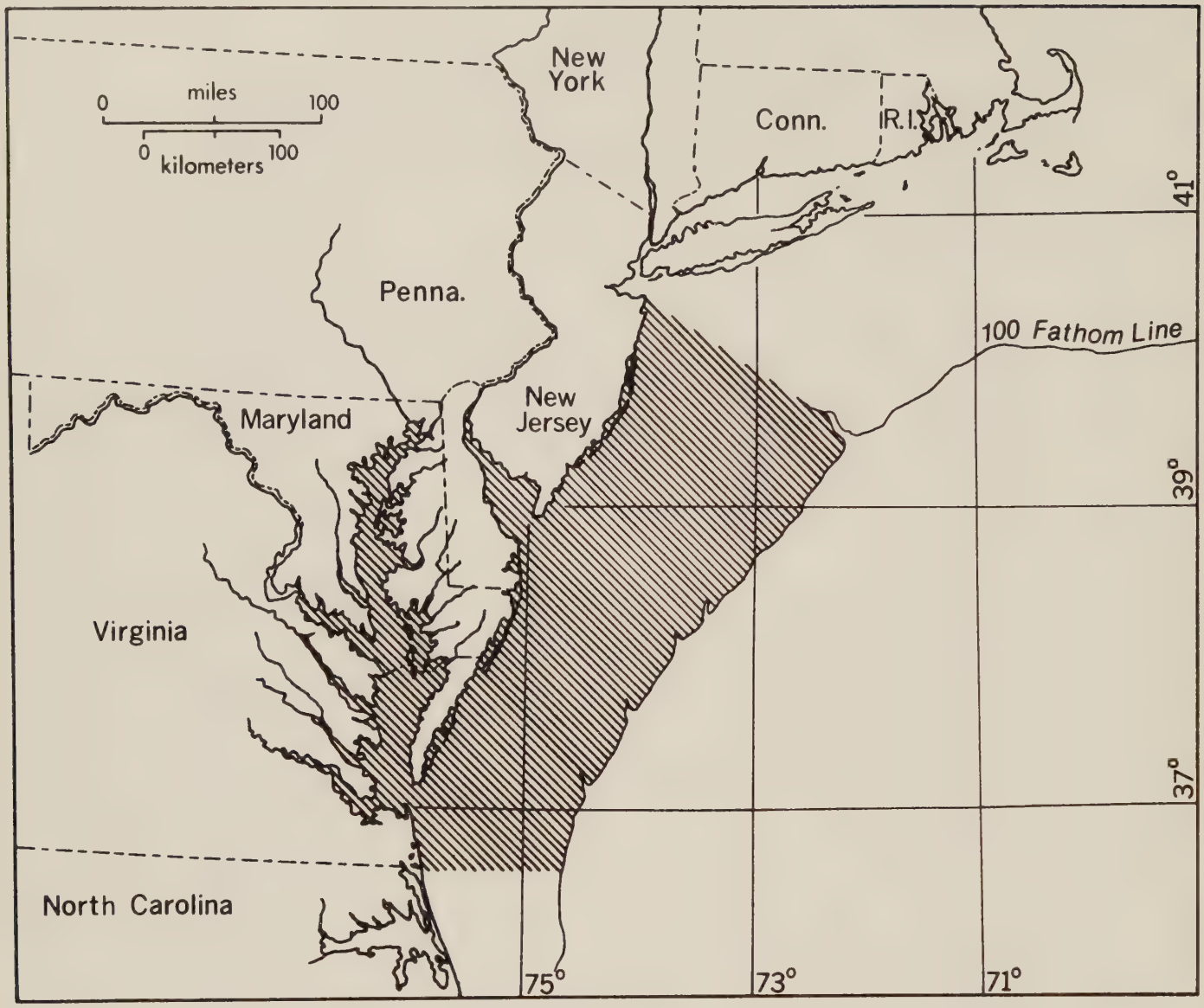

Fig. 1. Map of the Chesapeake Bay and adjacent Mid-Atlantic Bight. Hatching indicates the area considered in this series.

LITERATURE CITED—abbreviated citations to literature consulted for that account. Complete citations in Bibliography.

Superscript numbers in each species account refer to the abbreviated citations given at the end of each account. Complete citations may be found in the bibliography at the end of each volume. In prefaces, introductions, family accounts and figure legends, citations are given by author and date, rather than superscript. Throughout, parenthetical initials follow original unpublished information provided by the person whose initials are given (see preface for full name and address). Each volume has its own bibliography and index. No cumulative bibliography or index has been attempted.

Illustrations are of mixed quality and utility. For the most part they are simply reprinted from the literature. In some cases, however, previously published figures have been redrawn, and a number of original illustrations are in-

cluded. Figure legends cite the artist or delineator. Redrawings are usually of figures which are unique in that they provide the only illustrations of particular features or stages and will not reproduce well or are confusing or inaccurate in detail. Attempts have been made to exclude drawings of misidentified specimens, however, error in judgement is possible. Where available, multiple illustrations of the same stage are included if they show geographic variation or if the authors were unable to determine which illustration provided the most accurate representation. In addition, a number of drawings which have been published in rare or generally unavailable sources have been included primarily for their historic value.

TERMINOLOGY

For the most part, terminology and methods of measuring and counting are those of Hubbs and Lagler (1958), however, these terms are specifically for adult forms and must be modified or replaced by different ones for early developmental stages.

For illustrations of typical developmental stages and larval anatomy see fig. 2.

Definitions and terms for developmental stages vary considerably depending on the investigator and the species worked on. The following terminology has been standardized:

Yolk-sac larva—stage between hatching and absorption of yolk;

Larva—stage between absorption of yolk and acquisition of minimum adult fin ray complement;

Prejuvenile—stage between acquisition of minimum adult fin ray complement and assumption of adult body form; used only where strikingly different from juvenile (cf. Hubbs, 1958; *Tholichthys* stage of butterflyfishes, querimana stage of mullets, etc.);

Juvenile—stage between acquisition of minimum adult fin ray complement and sexual maturity or between prejuvenile stage and adult;

Adult—sexually mature.

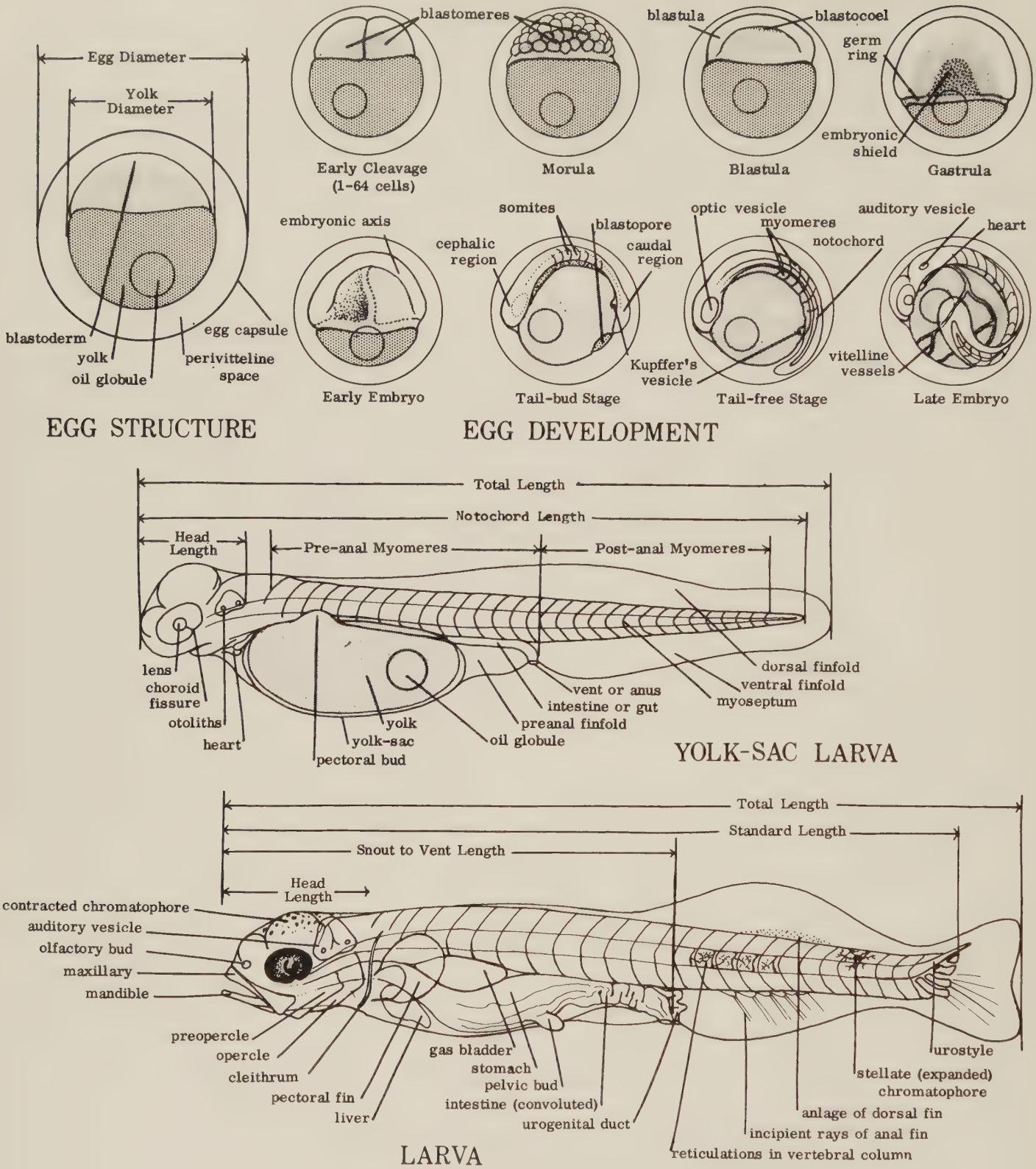

Fig. 2. Diagrammatic representation of morphology and development of egg and larval stages of a typical teleost.

GLOSSARY

A. Abbreviation for anal fin.

abbreviate heterocercal. Tail in which the vertebral axis is prominently flexed upward, only partly invading upper lobe of caudal fin; fin fairly symmetrical externally.

adherent. Attached or joined together, at least at one point.

adhesive egg. An egg which adheres on contact to substrate material or other eggs; adhesiveness of entire egg capsule may or may not persist after attachment.

adipose fin. A fleshy rayless median dorsal structure, located behind the true dorsal fin.

adnate. Congenitally united; conjoined.

adult. Sexually mature as indicated by production of gametes.

anadromous. Fishes which ascend rivers from the sea to spawn.

anal. Pertaining to the anus or vent.

anal fin. Unpaired median fin immediately behind anus or vent.

anal fin origin. Anteriormost point at which the anal fin attaches to the body.

anlage. Rudimentary form of an anatomical structure; primordium.

anus. External orifice of the intestine; vent.

auditory vesicle. Sensory anlage from which the ear develops; clearly visible during early development.

axillary process. Enlarged, accessory scale attached to the upper or anterior base of pectoral or pelvic fins.

BL. Abbreviation for body length.

barbel. Tactile process arising from the head of various fishes.

blastocoel. Cavity of the blastula; segmentation cavity.

blastoderm. Sensu strictu, early embryonic tissue composed of blastomeres; more generally, embryonic tissue prior to formation of embryonic axis.

blastodisc. Embryo-forming area of egg prior to cleavage.

blastomeres. Individual cells formed during cleavage.

blastopore. Opening formed by and bordered by the germ ring as it extends over the yolk.

blastula. Stage in embryonic development which represents the final product of cleavage stages, characterized by formation of the blastocoel.

body length. A specialized method of measuring, generally applied only to billfishes, and defined by Rivas (1956a) as the distance from the tip of the mandible (with jaws closed) to the middle point on the posterior margin of the middle caudal rays.

branched ray. Soft ray with two or more branches distally.

branchial arches. Bony or cartilaginous structures, supporting the gills, filaments and rakers.

branchiostegals. Struts of bone inserting on the hyoid arch and supporting, in a fanwise fashion, the branchiostegal membrane; branchiostegal rays.

buoyant egg. An egg which floats free within the water column; pelagic.

C. Abbreviation for caudal fin.

caeca. Finger-like outpouchings at boundary of stomach and intestine.

catadromous. Fishes which go to sea from rivers to spawn.

caudal fin. Tail fin.

caudal peduncle. Area lying between posterior end of anal fin base and base of caudal fin.

cheek. Lateral surface of head between eye and opercle, usually excluding preopercle.

chorion. Outer covering of egg; egg capsule.

choroid fissure. Line of juncture of invaginating borders of optic cup; apparent in young fish as a trough-like area below lens.

chromatophores. Pigment-bearing cells; frequently capable of expansions and contractions which change their size, shape, and color.

cirrus. Generally small, dermal, flap-like or tentacle-like process on the head or body.

cleavage stages. Initial stages in embryonic development where divisions of blastomeres are clearly marked; usually include 1st through 6th cleavages (2–64 cells).

cleithrum. Prominent bone of pectoral girdle, clearly visible in many fish larvae.

ctenoid scale. Scales with comb-like margin; bearing cteni.

cycloid scale. Scales with evenly curved free border, without cteni.

D. Abbreviation for dorsal fin.

demersal egg. An egg which remains on the bottom, either free or attached to substrate.

dorsal fins. Median, longitudinal, vertical fins located on the back.

dorsal fin origin. Point where first dorsal ray or spine attaches to body.

early embryo. Stage in embryonic development characterized by formation of embryonic axis.

egg capsule. Outermost encapsulating structure of the egg, consisting of one or more membranes; the protective shell.

egg diameter. In nearly spherical eggs, greatest diameter; in elliptical eggs given as two measurements, the greatest diameter or major axis and the least diameter or minor axis.

emarginate. Notched but not definitely forked, as in the shallowly notched caudal fin of some fishes.

embryonic axis. Primitive differentiation of the embryo; an elongate thickening of blastodermal tissue.

embryonic shield. Thickened shield-like area of the blastoderm at caudal edge of the germ ring.

erythrophores. Red or orange chromatophores.

esophagus. Alimentary tract between pharynx and stomach.

falcate. Deeply concave as a fin with middle rays much shorter than anterior and posterior rays.

finfold. Median fold of integument which extends along body of developing fishes and from which median fins arise.

FL. Abbreviation for fork length.

fork length. Distance measured from the anteriormost point of the head to the end of the central caudal rays.

ganoid scales. Diamond- or rhombic-shaped scales consisting of bone covered with enamel.

gas bladder. Membranous, gas-filled organ located between the kidneys and alimentary canal in teleosts; air bladder or swim bladder.

gastrula. Stage in embryonic development between blastula and embryonic axis.

germ ring. The thickened rim of the blastoderm evident during late blastula and gastrula stages.

germinal disc. The blastodisc.

gill arches. See branchial arches.

gill rakers. Variously-shaped bony projections on anterior edge of the gill arches.

granular yolk. Yolk consisting of discrete units of finely to coarsely granular material.

guanophores. White chromatophores; characterized by presence of iridescent crystals of guanine.

gular fold. Transverse membrane across throat.

gular plate. Ventral bony plate between anterior third of lower jaws, as in *Amia calva.*

heterocercal. Tail in which the vertebral axis is flexed upward and extends nearly to tip of upper lobe of caudal fin; fin typically asymmetrical externally, upper lobe much longer than lower.

HL. Abbreviation for head length.

head length. Distance from anteriormost tip of head to posteriormost part of opercular membrane, excluding spine; prior to development of operculum, measured to posterior end of auditory vesicle.

holoblastic. Type of cleavage in which the entire egg, including the yolk, undergoes division.

homocercal. Tail in which the vertebral axis terminates in a penultimate vertebra followed by a urostyle (the fusion product of several vertebral elements); fin perfectly symmetrical externally.

hypochord. A transitional rod of cells which develops under the notochord in the trunk region of some embryos.

hypurals. Expanded, fused, haemal spines of last few vertebrae which support caudal fin.

incubation period. Time from fertilization of egg to hatching.

interorbital. Space between eyes over top of head.

iridocytes. Crystals of guanine having reflective and iridescent qualities.

isocercal. Tail in which vertebral axis terminates in median line of fin, as in Gadiformes.

isthmus. The narrow area of flesh in the jugular region between gill openings.

jugular. Pertaining to the throat.

juvenile. Young fish after attainment of minimum adult fin ray counts and before sexual maturation.

keeled. With a ridge or ridges.

Kupffer's vesicle. A small, vesicular, ventro-caudal pocketing which forms as blastopore narrows.

larva. Young fish between time of hatching and attainment of minimum adult fin ray counts.

late embryo. Stage prior to hatching in which the embryo has developed external characteristics of its hatching stage.

lateral line. Series of sensory pores and/or tubes extending backward from head along sides.

lateral line scales. Pored or notched scales associated with the lateral line.

mandible. Lower jaw, comprised of three bones: dentary, angular and articular.

maxillary. The dorsalmost of the two bones in the upper jaw.

Meckel's cartilage. Embryonic cartilaginous axis of the lower jaw in bony fishes.

melanophores. Black chromatophores.

mental. Pertaining to the chin.

meroblastic. Type of cleavage in which only the blastodisc undergoes division.

micropyle. Opening in egg capsule through which spermatozoa enter.

morula. Stage in development of egg in which blastomeres form a mulberry-like cluster.

myomeres. Serial muscle bundles of the body.

myoseptum. Connective tissue partitions separating myomeres.

nape. Area immediately posterior to occipital region.

nasal. Pertaining to region of the nostrils, or to the specific bone in that region.

NL. Abbreviation of notochord length.

notochord. Longitudinal supporting axis of body which is eventually replaced by the vertebral column in teleostean fishes.

notochord length. Straight-line distance from anteriormost part of head to posterior tip of notochord; used prior to and during notochord flexion.

occipital region. Area on dorsal surface of head, beginning above or immediately behind eyes and extending backwards to end of head.

oil globule(s). Discrete sphere(s) of fatty material within the yolk.

olfactory buds. Incipient olfactory organs.

optic vesicles. Embryonic vesicular structures which give rise to the eyes.

otoliths. Small, calcareous, secreted bodies within the inner ear.

P. Abbreviation for pectoral fin.

palatine teeth. Teeth on the paired palatine bones in the roof of the mouth of some fishes.

pectoral bud. Swelling at site of future pectoral fin; anlage of pectoral fin.

pectoral fins. Paired fins behind head, articulating with pectoral girdle.

pelagic. Floating free in water column; not necessarily near the surface.

pelvic bud. Swelling at site of future pelvic (ventral) fins; anlage of pelvic fin.

pelvic fins. Paired fins articulating with pelvic girdle; ventral fins.

periblast. A layer of tissue between the yolk and cells of blastoderm which is observed as a thin border around blastula.

peritoneum. Membranous lining of abdominal cavity.

perivitelline space. Fluid-filled space between egg proper and egg capsule.

pharyngeal teeth. Teeth on the pharyngeal bones of the branchial skeleton.

postanal myomeres. The number of myomeres between posterior margin of anus and the most posterior myoseptums.

preanal length. Method of measuring often not stated, assumed to be about equivalent to snout to vent length in larvae.

preanal myomeres. The number of myomeres between the anteriormost myoseptum and the posterior margin of anus.

predorsal scales. Scales along dorsal ridge from occiput to origin of dorsal fin.

prejuvenile. Developmental stage immediately following acquisition of minimum fin ray complement of adult and before assumption of adult-like body form; used only where strikingly different from juvenile (*cf.* Hubbs, 1958; *Tholichthys* stage of butterflyfishes, querimana stage of mullets, etc.).

premaxillary. The ventralmost of the two bones included in the upper jaw.

primordium. Rudimentary form of an anatomical structure; anlage.

principal caudal rays. Caudal rays inserting on hypural elements; the number of principal rays is generally defined as the number of branched rays plus two.

procurrent caudal rays. A series of much shorter rays anterior to the principal caudal rays, dorsally and ventrally, not typically included in the margin of the caudal fin.

pronephric ducts. Ducts of pronephric kidney of early developmental stages.

scute. A modified, thickened scale, often spiny or keeled.

sigmoid heart. The S-shaped heart which develops from the primitive heart tube.

SL. Abbreviation for standard length.

snout to vent length. Distance from anteriormost part of head to posterior margin of anus; the precise method of measurement often not stated.

soft rays. Bilaterally paired, usually segmented, fin supports.

somites. Primitive, segmented, mesodermal tissue along each side of notochord.

spines. Unpaired, unsegmented, unbranched fin supports, usually (but not always) stiff and pungent.

standard length. In larvae, straight-line distance from anteriormost part of head to end of hypural ele-

ments; not applicable to larvae prior to notochord flexion. (In juveniles and adults measured from most anterior point of snout or upper lip.)

stomodeum. Primitive invagination of the ectoderm which eventually gives rise to the mouth.

tail-bud stage. Stage of embryonic development characterized by a prominent caudal bulge and marked development of cephalic region.

tail-free stage. Stage of embryonic development characterized by separation of the tail from the yolk.

TL. Abbreviation for total length.

total length. Straight-line distance from anteriormost part of head to tip of tail; all older literature references not stated differently are assumed to be total length.

urostyle. Terminal vertebral element in higher teleosts, derived from the fusion and loss of several of the most posterior centra of the more primitive forms.

V. Abbreviation for the central or pelvic fin.

vent. Anus.

ventral fins. Paired fins articulating with the pelvic girdle; pelvic fins.

vitelline vessels. Arteries and veins of yolk region.

water-hardening. Expansion and toughening of egg capsule due to absorption of water into the perivitelline space.

width of perivitelline space. Distance between yolk and egg capsule expressed either as direct measurement or a ratio of the egg diameter.

xanthophores. Yellow chromatophores.

yolk. Food reserve of embryonic and early larval stages, usually seen as a yellowish sphere diminishing in size as development proceeds.

yolk diameter. Greatest diameter of yolk; more accurately measurable prior to embryo formation.

yolk plug. Yolk within the blastopore.

yolk sac. A bag-like ventral extension of the primitive gut containing the yolk.

yolk-sac larva. A larval fish characterized by the presence of a yolk-sac.

VOLUME IV DEDICATION

This volume is dedicated to my parents
George and Helen Johnson.

INTRODUCTION TO VOLUME IV

This fourth volume of the *Development of Fishes of the Mid-Atlantic Bight* includes accounts on fifty-two species of teleosts in ten families (Carangidae through Ephippidae). Within the ten families, I am aware of only one species recorded from this region which has not been treated here. Hildebrand and Schroeder (1928) report a single specimen of *Umbrina coroides* taken from Chesapeake Bay in 1921. This species has not subsequently been recorded from the area and was thus not included here.

The standard series format is followed with one addition. Predorsal patterns are given in several family accounts using the formula proposed by Ahlstrom, Butler and Sumida (1976).

This volume represents a review and summary of the existing literature pertinent to the species included. Since time constraints precluded the possibility of original work and first-hand examination of specimens, review of the preliminary manuscripts by appropriate experts was a crucial step in providing accurate accounts. In many cases, the reviewers not only pointed out misleading inaccuracies in the literature, but contributed valuable original data as well. In this regard I am particularly indebted to Frederick H. Berry of the National Marine Fisheries Service for his invaluable review of the twenty-two species of Carangidae. He provided important original data and numerous illustrations, and his efforts tremendously improved the quality and utility of the carangid section. The Sciaenidae were reviewed by Howard W. Powles and Bruce W. Stender of the M.R.R.I. of South Carolina and Labbish N. Chao of the Museum of Natural Sciences, Ottawa. The expertise of Powles and Stender with sciaenid larvae enabled them to correct previous literature inaccuracies, and they also offered some of their own data. Chao was particularly helpful with adult and juvenile descriptions. Thomas Potthoff of the National Marine Fisheries Service reviewed the Coryphaenidae and offered considerable data from his doctoral dissertation. I would also like to thank the following persons for reviewing manuscripts: Sparidae, David K. Caldwell, Biocommunication and Marine Mammal Research Facility, University of Florida; Bramidae, Giles Mead, Los Angeles County Museum of Natural History; Mullidae, Ernest A. Lachner, U.S. National Museum; Gerreidae, Bernard Zahuranec, Office of Naval Research; Haemulidae, William J. Richards, National Marine Fisheries Service; Kyphosidae, Ronald A. Fritzsche, Chesapeake Biological Laboratory; Ephippidae, F. Douglas Martin, Chesapeake Biological Laboratory. Special thanks are due all those associated with this project for their willing assistance, cooperation, and rarely faltering esprit de corps: J. David Hardy, Jr., F. Douglas Martin, Ronald A. Fritzsche, George Drewry, Julia Clark, Lisa Ray Peters and Cindy Simmonds.

Original unpublished contributions are indicated by the initials of the contributor as follows:

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GDJ G. David Johnson, Chesapeake Biological Laboratory, Solomons, Maryland.
FDM F. Douglas Martin, Chesapeake Biological Laboratory, Solomons, Maryland.
HWP Howard W. Powles, Marine Resources Research Institute, Charleston, South Carolina.
BWS Bruce W. Stender, Marine Resources Research Institute, Charleston, South Carolina.

Alectis ciliaris
Caranx bartholomei
Caranx crysos
Caranx hippos
Caranx latus
Chloroscombrus chrysurus
Decapterus macarellus
Decapterus punctatus
Elagatis bipinnulata
Oligoplites saurus
Selar crumenophthalmus
Selene setapinnis
Selene vomer
Seriola dumerili
Seriola fasciata
Seriola rivoliana
Seriola zonata
Trachinotus carolinus
Trachinotus falcatus
Trachinotus goodei
Trachurus lathami
Uraspis secunda

jacks and pompanos
Carangidae

FAMILY CARANGIDAE

Carangids are active-swimming predatory fishes distributed worldwide in tropical and temperate seas. A few readily enter fresh water but return to the sea to spawn. There are an estimated 200 species in the family, 22 of which (in 12 genera) have been recorded at some developmental stage from the Chesapeake Bay region.

The carangid body form ranges from the elongate fusiform scads (*Decapterus*) to the deep bodied, compressed pompanos (*Trachinotus*) and lookdowns (*Selene*). They are usually silvery in color and are most notably characterized by having the two anteriormost anal spines detached from the remainder of the anal fin. The dorsal fin is deeply notched or completely separated, the spinous portion often reduced or even embedded in large adults. The lateral line is complete, highly arched anteriorly, and frequently bears enlarged scutes posteriorly. Other significant characteristics are as follows: first dorsal with eight or fewer spines, second dorsal with one spine and 16–39 soft rays (Ahlstrom and Sumida, MS); anal fin with three spines (two detached) and 15–33 soft rays (Ahlstrom and Sumida, MS); pelvic fins I, 5; pelvic axillary process absent; teeth usually present on vomer and palatines; branchiostegals 5–8 (usually 7); subocular shelf usually present on second suborbital, absent in some; vertebrae 10 + 14 to 16 (usually 14); principal caudal rays 9 + 8; caudal usually with two uroneurals and three epurals; procurrent spur absent. (GDJ)

Most, if not all, spawn offshore and produce pelagic eggs. The larvae are pigmented, particularly on the head, along the dorsal and ventral margins of the body, and usually along the lateral line. Pigmentation is heaviest in the later stages. They typically possess heavy preopercular spination, supraocular ridge above the eyes, and post-temporal spines on the shoulder. A median supraoccipital crest is characteristic of larvae of many genera, and is present in seven of the 11 genera treated here (*Trachurus, Caranx, Chloroscombrus, Alectis, Selene, Elagatis,* and *Decapterus*). This crest develops prior to flexion, and remains well developed until the late larval or juvenile stage, when it recedes and finally disappears. There are two series of preopercular spines, a series of small uniform spines along the preopercular crest and a series of larger graduated ones (the largest at the angle) along the margin. The angular spine may be serrated as in *Elagatis* and *Oligoplites*. The number of preopercular spines gradually increases from preflexion to postflexion when the spines begin to decrease in size and finally disappear. A supraocular ridge develops to some extent in most carangid larvae, but is particularly conspicuous in those genera which lack the supraoccipital crest such as *Oligoplites, Seriola* and *Trachinotus* (Ahlstrom and Sumida, MS).

The larvae of the genus *Selene* are quite distinctive in having precocious pelvic fins with elongated rays, as well as several elongated dorsal spines. Precocious pelvic fins and elongated dorsal and anal fin rays also characterize the genus *Alectis*. Other characters useful in identifying carangid larvae to species are sequence of fin formation and meristics such as median fin rays, gill rakers, branchiostegal rays, vertebrae, predorsals, epurals, hypurals, and teeth (Ahlstrom and Sumida, MS).

Alectis ciliaris (Bloch), African pompano

ADULTS

D. VII–I, 18–19 [2,3] (predominantly 19 [2]), first 7 spines covered by skin,[2,3] resorbed by 500 mm FL (FHB); A. II–I, 15–16 [2,3] (predominantly 16 [2]), first 2 spines covered by skin; [2,3] C. 9+8, procurrent rays 9–10+9; [9] P. 18–20 (predominantly 19 [2]); V. I, 5; [12] lateral line scales about 120–140, 24–41 in posterior part modified as scutes; [8] vertebrae 10+14; [9] gill rakers 4–5+15–16; [3] teeth small, in a band at symphysis of jaws, tapering backwards; teeth sparse on head of vomer and palatines, none on shaft of vomer; a fairly wide band of teeth on tongue.[2]

Head 2.9, depth 1.3, pectoral 2.8 in SL; snout 3.3, eye 3.5, interorbital 2.9, maxillary 2.5 in head.[12]

Body compressed; dorsal profile from origin of soft dorsal to over eye straight, becoming nearly horizontal in larger specimens; [2] profile of head blunt and nearly vertical; [3] ventral profile rounded to anal origin, thence a nearly straight inclined line to caudal peduncle; anus midway between pelvic base and first anal spine; mouth medium, inclined, lower jaw moderately projecting; maxillary ending approximately under anterior margin of pupil.[2] Scales on body minute, embedded; [2,3] cheek partly scaled, rest of head scaleless; side of belly scaleless, rest of body largely scaled up to an irregularly curved line from origin of first dorsal to upper angle of gill opening, except for irregular scaleless areas above and below lateral line. Anterior curve in lateral line high, subequal to straight part; posterior scutes forming a well developed keel, a few normal scales behind scutes to end of hypural; accessory lateral line reaching to posterior margin of head or a little behind.[2] Spines of first dorsal fin completely covered by skin and molded into body profile by 100–120 mm; [3] fold at base of dorsal and anal fin moderately developed; [2] first 7 soft rays of dorsal and first 5 soft rays of anal fins extremely elongate and filiform in the young, progressively shorter with age [8] (however adults to 590 mm have been found with fin rays twice as long as body [13]); caudal fin shorter than head; pectoral fin reaching a little beyond posterior bend in lateral line; pelvics reaching nearly to first anal spine.[2]

Pigmentation: Color when fresh, bright blue [15] to bluish green [3] above, becoming silvery on sides and below; a narrow brownish streak from upper part of gill opening to middle of base of soft dorsal; pectoral tipped with black; upper fin dusky, the lower fin white.[15]

Maximum size: Largest recorded 892 mm.[4]

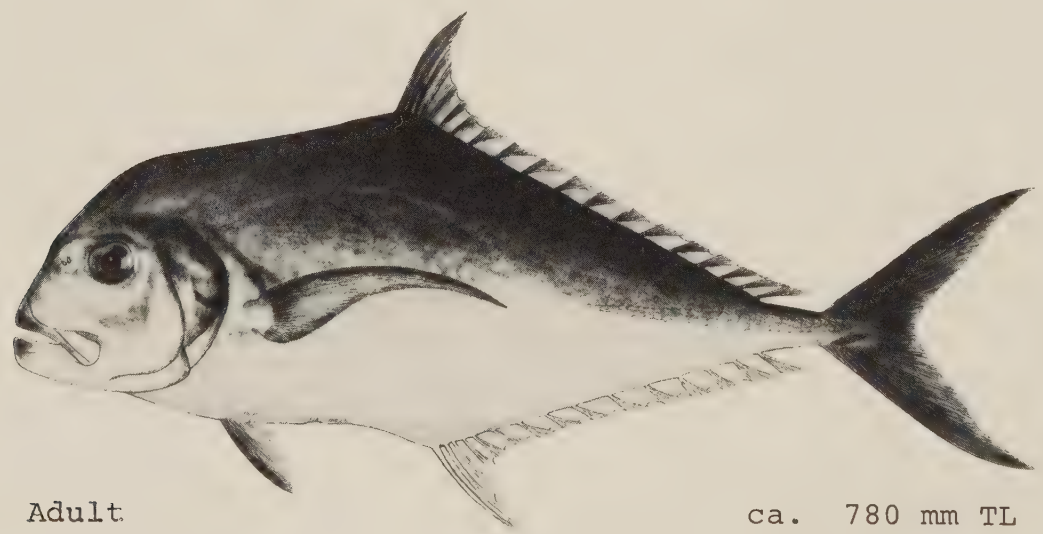

Fig. 3. *Alectis ciliaris,* African pompano. A. Adult, ca. 780 mm TL. (*Berry, F. H., MS.*)

Fig. 4. *Alectis ciliaris,* African pompano. A. Juvenile, ca. 15 mm SL. (*Fowler, H. W., 1944: fig. 167.*)

DISTRIBUTION AND ECOLOGY

Range: Worldwide in tropical and subtropical waters (FHB); in the western Atlantic from Massachusetts to Santos, Brazil,[3] including the Gulf of Mexico; [5] adults not reported north of southern Florida.[11]

Area distribution: Chesapeake Bay at Lynnhaven Roads, Virginia,[12] and Dorchester and Calvert counties, Maryland; [14] Worcester County, Maryland; [7] Atlantic, Cape May and Ocean counties, New Jersey.[10]

Habitat and movements: Adults—an open water fish; [8] often caught on bottom in 12 to 36 m (FHB).

Larvae—no information.

Juveniles—taken June–November in Massachusetts.[6] A sluggish specimen dip netted in Chesapeake Bay at 15.2 ppt and 18 C.[14]

SPAWNING

Smallest specimens taken offshore from July to September.[3]

EGGS

No information.

EGG DEVELOPMENT

No information.

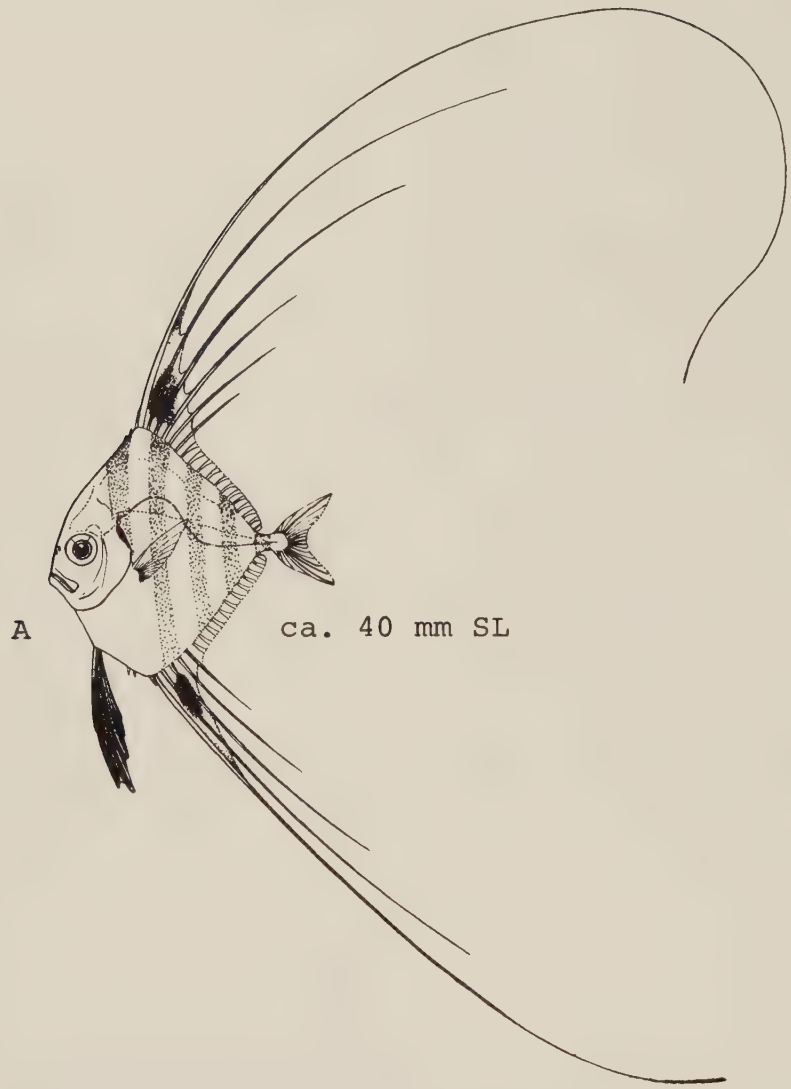

Fig. 5. *Alectis ciliaris*, African pompano. A. Juvenile, ca. 40 mm SL. (*Fowler, H. W., 1936: fig. 314.*)

YOLK-SAC LARVAE

No information.

LARVAE

No information. The identity of the larvae and juveniles described by Aboussouan (1968) was corrected to *A. alexandrinus* in a postscript.[1]

JUVENILES

Body depth and pelvic length decrease strikingly with growth:

SL	% SL	
	*depth	pelvic
13 mm	92	87
20–28 mm	98–106	74–77
45–51 mm	94–100	64–74
75–96 mm	86–99	50–55
98–102 mm	78–79	40–47
110–118 mm	75–86	30–43
129–166 mm	67–78	21–29
187–223 mm	59–63	17–18
444 mm	48	15

*Depth measured from origin of second dorsal to apex of ventral contour in smaller specimens and to origin of anal in others.[2]

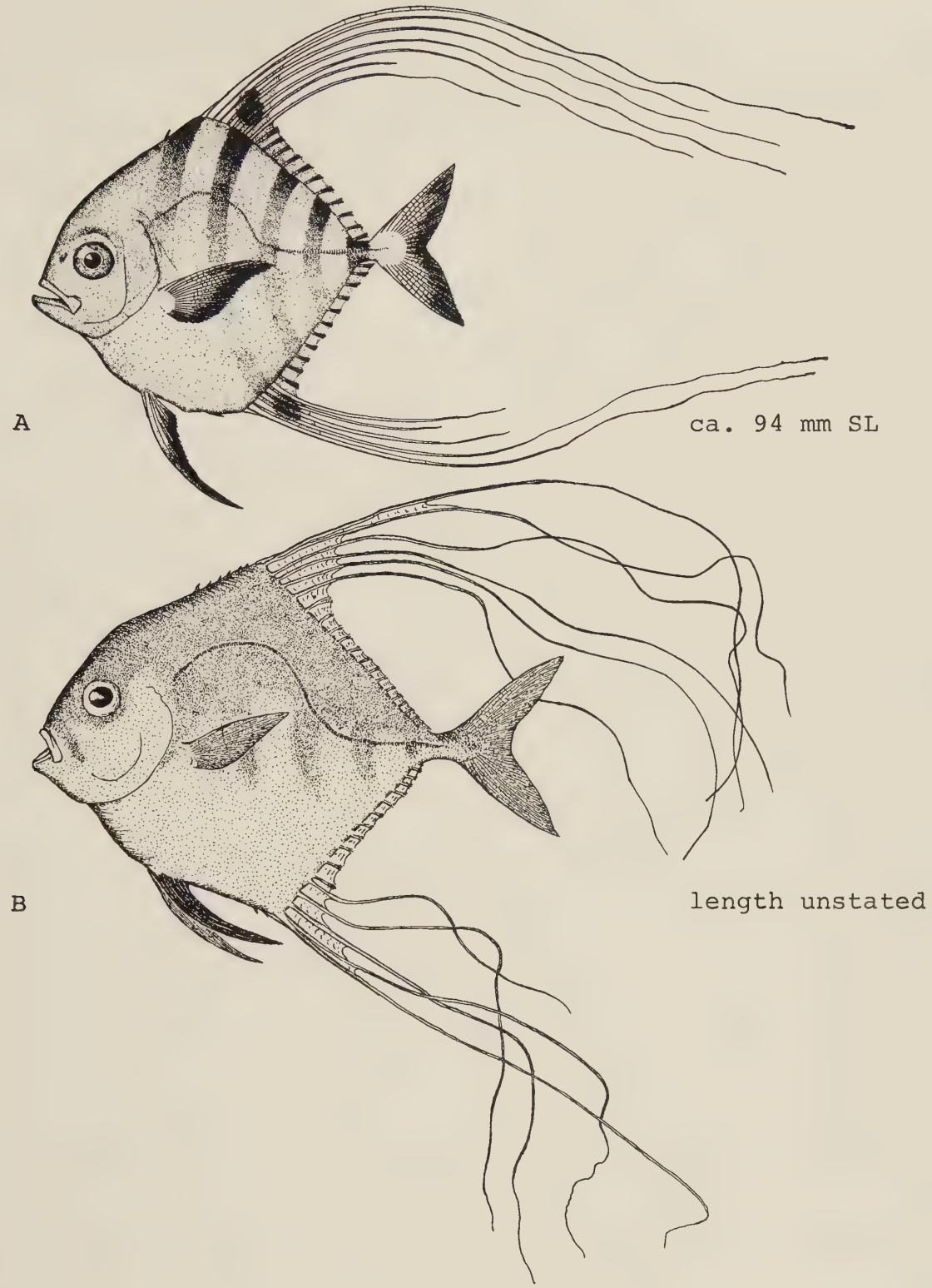

Fig. 6. *Alectis ciliaris*, African pompano. A. Juvenile, ca. 94 mm SL. B. Juvenile, length unstated. (*A, Smith, H. W., 1907: fig. 86. B, Bigelow, H. B., and W. C. Schroeder, 1953: fig. 207.*)

At 9–23 mm dorsal fin with 7 short pungent spines, only partly connected by a membrane, distal ends free; spines initially moderately inclined backwards, the angle of inclination increasing with growth until it approaches dorsal contour; tips of most spines still evident to about 155 mm; at 185 mm (sometimes as early as 95 mm) spines not evident at surface but some may be raised under skin; by 444 mm spines have merged with slightly irregular dorsal contour. To 157 mm longest dorsal rays vary from 2–4 times SL; between 166–223 mm longest dorsal rays vary from 1–2 times SL. Size at which first 2 anal spines completely covered quite variable; at least 1 usually covered by 51–76 mm, but sometimes both retained to almost 100 mm; both spines sometimes covered as early as 77 mm, and almost always covered by 150 mm (1 specimen 187 mm had 1 spine present).[2]

Pigmentation: In life body with 4 broad crossbands, the posterior 3 sometimes continued below, becoming fainter and oblique on lower body; a dark transversely elongate blotch at upper posterior edge of opercle; a large black spot at base of prolonged dorsal rays; pelvics and filamentous dorsal and anal rays dark or black.[2]

Characterized by shape of body, steeply rising anterior profile in combination with long, filamentous soft dorsal and anal rays. Distinguished from *Selene vomer* and *Selene setapinnis* by well developed spinous lateral line scutes, less numerous dorsal rays and gill rakers, and absence of spinous dorsal at surface;[2] pectoral fin remains relatively long in *Alectis* whereas it is reduced to short rudiment in adult *Selene* (FHB).

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Caranx bartholomei Cuvier, Yellow jack

ADULTS

D. VIII–I, 25–28 [1] (modally 26 [12]); A. II–I, 21 [1]–25 [5] (modally 23 [12]); C. 9 + 8, procurrent rays 8–9 + 7–9; P. 20–22 [1] (predominantly 21 [12]); V. I, 5; [1] lateral line scales 91–114, the last 25–36 as scutes,[5] 22–28 scutes in straight part of lateral line; [1] vertebrae 10 + 14; [6] gill rakers 6–9 + 18–21; [1] branchiostegals 7; [1] teeth small, in a narrow band in each jaw,[10,12] without distinct canines; villiform teeth on vomer, palatines and tongue,[10] vomerine patch particularly well developed.[12]

Head 2.8 [11]–3.2,[10] depth 2.0 [11]–2.8,[10] pectoral 2.8–4.2 in SL; eye 2.8–4.0, snout 2.8–3.4, maxillary 2.2–2.5 in head.[11]

Body moderately deep,[3] ovate, compressed; anterior profile elevated, forming an even, continuous curve from snout to base of dorsal; mouth oblique, terminal,[15] maxillary not reaching to front of pupil; [10] supramaxillary present.[15] Anterior curve in lateral line moderately high, most scales in posterior straight part scute-like, transversely expanded, with a long keel ending in a sharp, backwardly directed point; [12] curved portion 1–1.4 in straight portion.[1] Scales small; cheek and upper part of opercle scaled, most of opercle and rest of head scaleless; a narrow naked strip on mid-back tapering backward to dorsal origin; [12] chest fully scaled.[1] Dorsal and anal fin lobes moderately produced; [3] soft dorsal and anal fins partially covered with scales; pectoral fins falcate, a little shorter than head, reaching past front of anal; [10] caudal broadly forked.[15]

Pigmentation: Color in life generally bluish silver, more or less suffused with olive yellow,[14] or golden [10] and with rich blue purple, and green reflections; ventral midline white; top of head olive; midline of back yellow; [14] no black on opercle or lower lobe of caudal.[10] Characterized by olive yellow suffusion and richness of all colors.[14]

Maximum size: Largest recorded 955 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: In the western Atlantic from Woods Hole, Massachusetts to Maceio, Brazil.[1]

Area distribution: Chesapeake Bay at Kiptopeke, Virginia; [2] Ocean County, New Jersey.[7]

Habitat and movements: Adults—not common inshore, more often found over outer reefs; usually solitary or in very small groups; [5] numerous records at Woods Hole from August to November.[8]

Larvae—associated with offshore currents.[1]

Juveniles—early juveniles generally associated with offshore currents, at least some moving into inshore waters as late juveniles [1] (before 75 mm [4]); frequently found in association with jellyfish [3] and drifting *Sargassum;* [3,8] occur in Gulf Stream from May–November; population in southeast Atlantic coast of U.S. appears to be largely the result of recruitment from waters to the south via the Gulf Stream; during colder months either returns to south or moves to warmer offshore waters. Taken in salinities from 35.2–36.7 ppt and temperatures from 20.4–29.4 C.[1]

SPAWNING

Location: Occurs principally in offshore waters,[3] the major area being south of the U.S.[1]

Season: Takes place February through October,[4] and perhaps as early as mid-January.[9]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

To about 8 mm.

At 6.0 mm all dorsal spines well formed, 25 soft rays present; anal spines well formed, second anal spine two thirds as long as longest anal soft ray; principal caudal rays present and segmentation has begun; pectoral with about 14 rays; all pelvic rays discernible; nostrils undivided; supraoccipital crest serrated; cleithrum with 2 posterolaterally projecting spines just below its junction with opercle.[1]

Pigmentation: At 6.0 mm 2 rows of elongate melanophores, 1 below base of dorsal fin and one on midline posteriorly; a few melanophores scattered over body, snout, mouth parts, and opercle; a group of denser melanophores over eye on transparent part of head; a few pigment spots on interspinous membranes of dorsal and anal fins; on pelvics and along base of anal soft rays.[1]

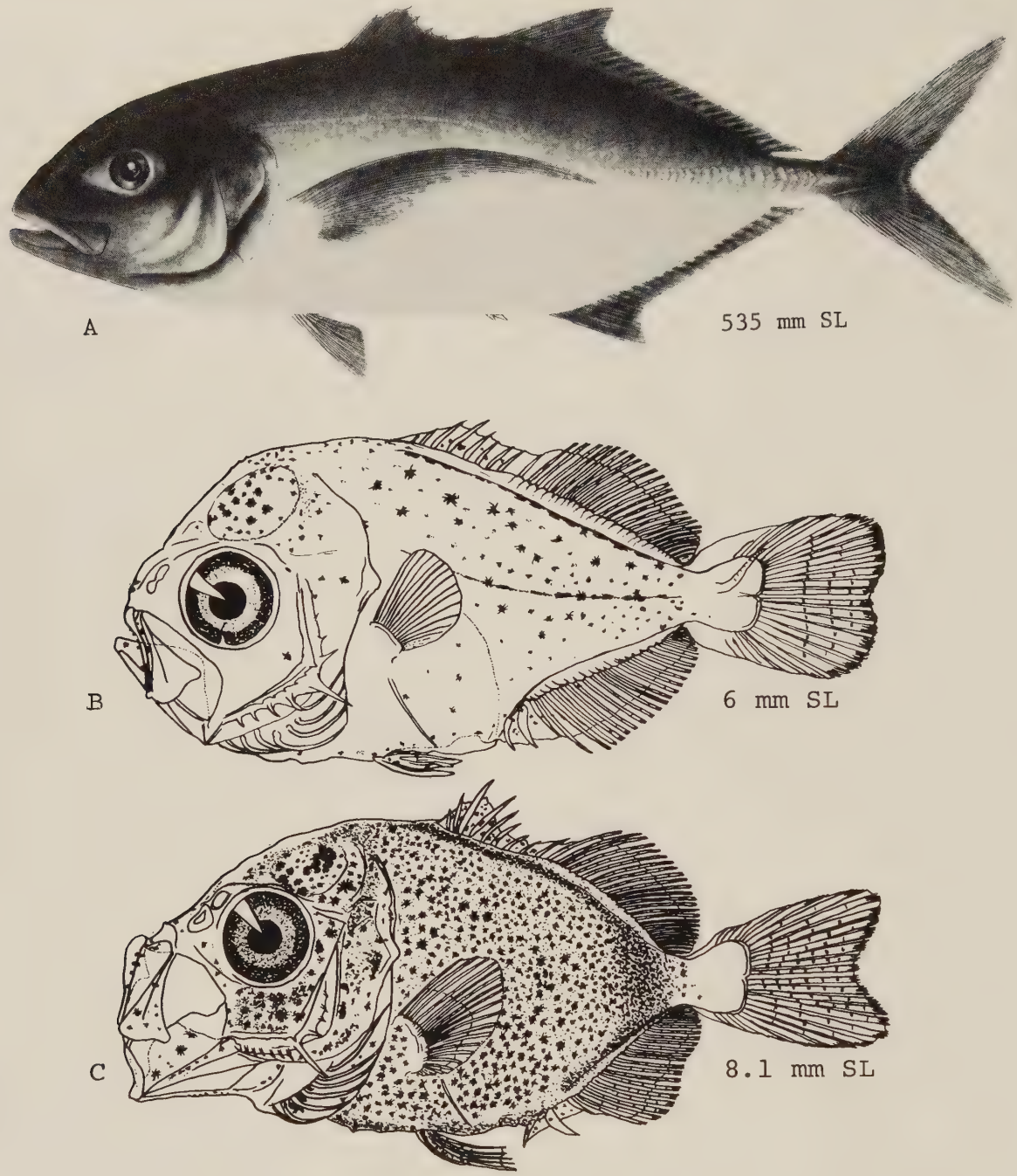

Fig. 7. *Caranx bartholomei*, Yellow jack. A. Adult, 535 mm SL. B. Larva, 6 mm SL. C. Larva, 8.1 mm SL. (*A, Berry, F. H., MS. B, C, Berry, F. H., 1959: figs. 48–49.*)

JUVENILES

About 8 mm and larger.

Depth at first anal spine averages less than depth at pelvics to about 45 mm and greater above 55 mm. Dorsal with full complement of rays by 8.1 mm; terminal ray branched to base by 10.5 mm, other rays branched between 17–20 mm; extension of anterior 5 or 6 rays to produce lobe begins at about 15 mm and is pronounced by 30 mm; second ray averages longest to about 23 mm, first ray longest above 23 mm; fourth spine averages longest to about 33 mm, above 33 mm third spine longest; interspinous membrane connects eighth and ninth spines to about 90 mm and seventh and eighth spines to about 176 mm. Segmentation and branching of anal soft rays occur as in dorsal; second ray averages longest

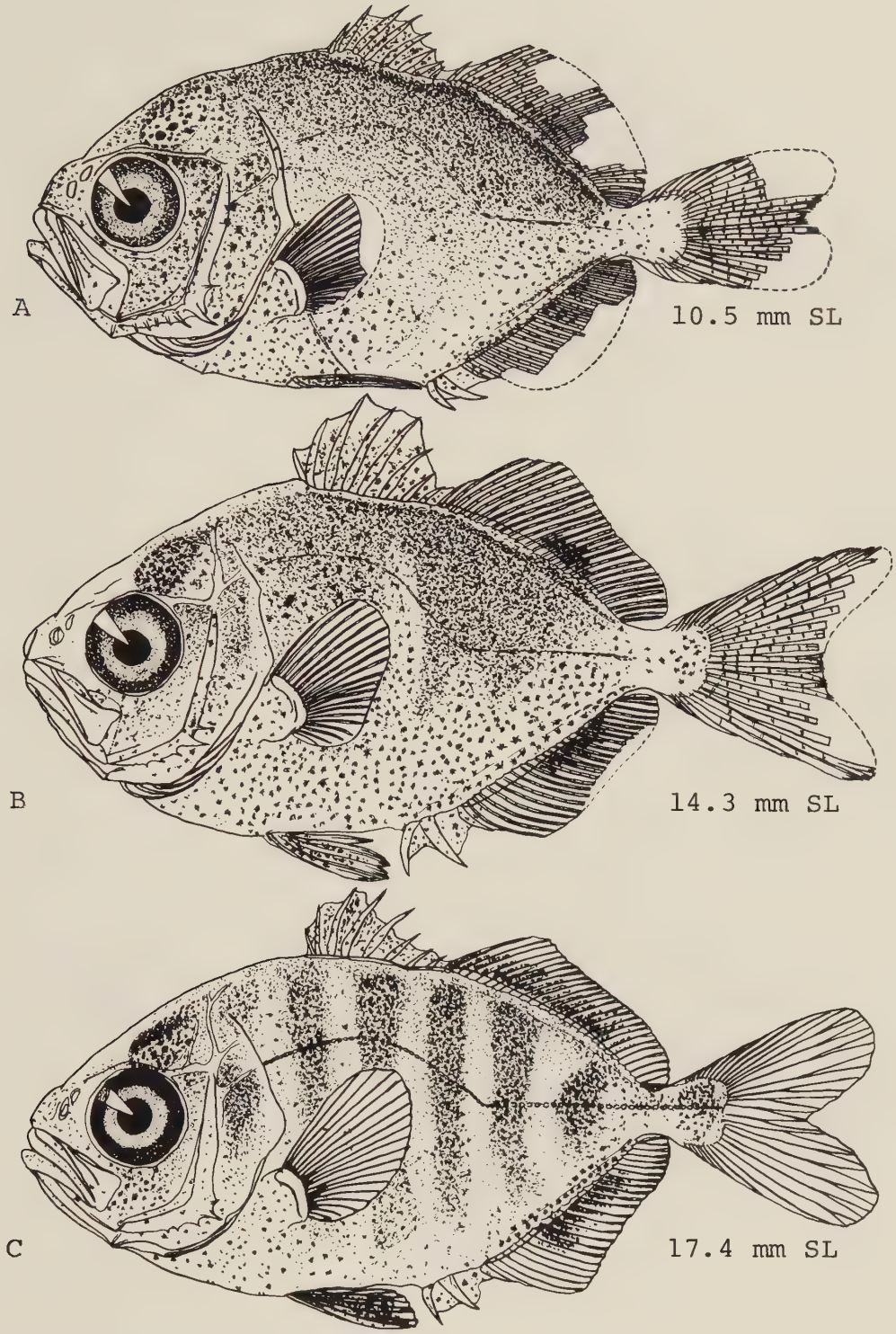

Fig. 8. *Caranx bartholomei,* Yellow jack. A. Juvenile, 10.5 mm SL. B. Juvenile, 14.3 mm SL. C. Juvenile, 17.4 mm SL. *(Berry, F. H., 1959: figs. 50–52.)*

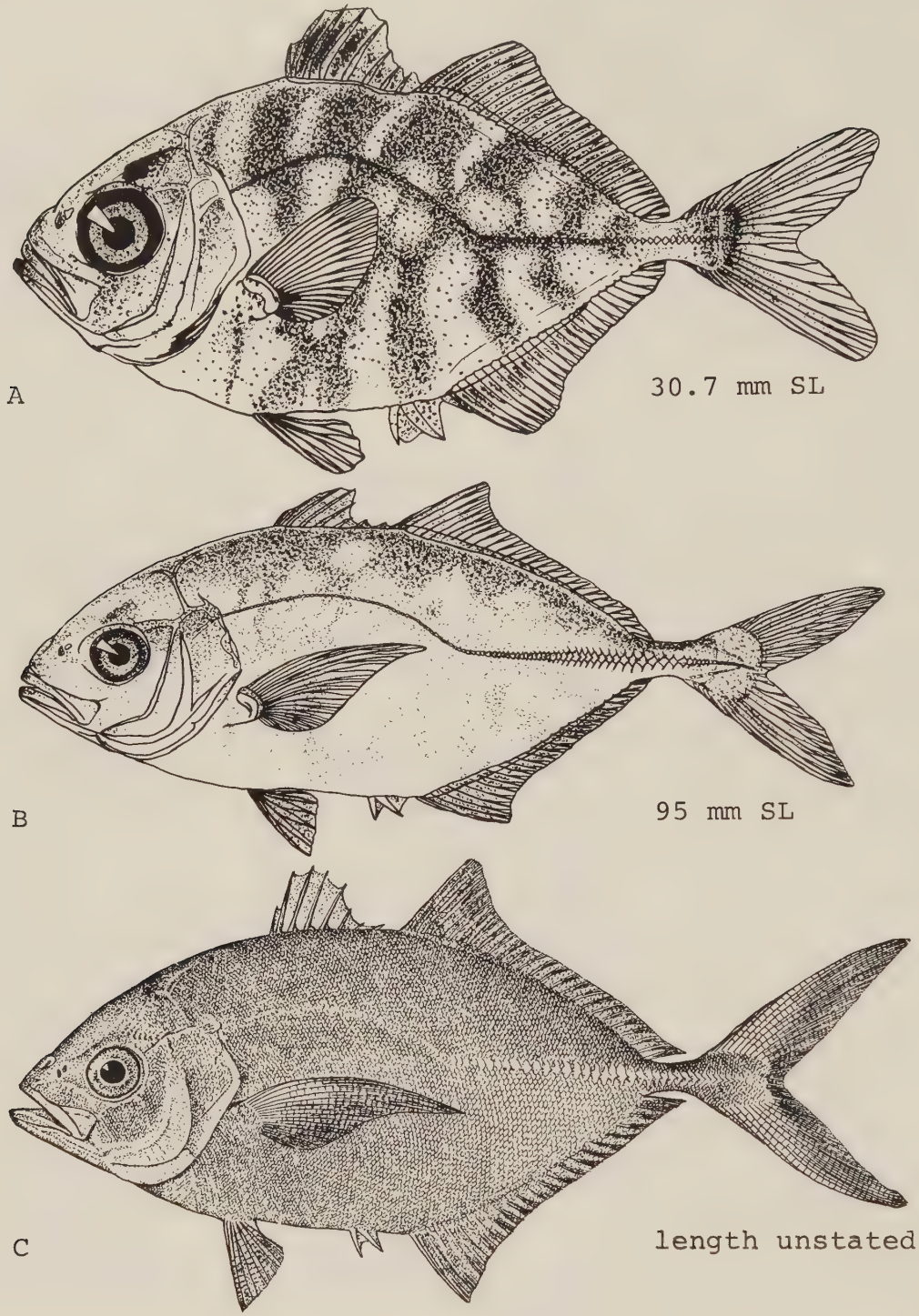

Fig. 9. *Caranx bartholomei*, Yellow jack. A. Juvenile, 30.7 mm SL. B. Juvenile, 95 mm SL. C. Juvenile, length unstated. (*A, B, Berry, F. H., 1959: figs. 53–54. C, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 389.*)

to about 23 mm, first longest above 23 mm; second spine longer than first at all sizes; interspinous membrane connects second and third spines to about 35 mm. At 8.1 mm 1 or 2 dorsal and ventral procurrent rays unformed, but full complement present by 10.5 mm; branching begins at about 10 mm and is pronounced by 16.0 mm; forking is pronounced by 8.1 mm. Pectoral with full complement of rays by 8.1 mm; branching has begun by 25 mm; fin rounded to 35 mm when falcation begins; falcation pronounced by 95 mm. Branching of pelvic rays has begun by 15 mm. Developing scutes appear between 12.7–14.3 mm; between 22–23 mm first scutes complete development; all scutes complete or nearly complete by 80–100 mm. Nostrils divided at 8.1 mm. Serrations on supraoccipital crest lost by 8.1 mm. Cleithral spines absent by 8.1 mm. Spine at preopercular angle begins to decrease in length at some size smaller than 12 mm and is completely covered by preopercular margin between 32.5–39 mm.[1]

Pigmentation: At 8.1 mm an appreciable increase in number of pigments spots on body, head, and first dorsal and pelvics; the dorsal and lateral rows of elongate melanophores are not apparent and there is only 1 pigment spot at base of anal spot rays; a dense concentration of pigment present on anterior portion of caudal peduncle, and fleshy portion of caudal fin conspicuously unpigmented.[1]

At 10.5 mm pigment spots occur basally between the soft rays of the dorsal and anal fins. Between 10.5–14 mm body pigment intensifies. By 14 mm transparent part of brain case opaque and melanophores on this area increase and are extended posterodorsally to form nuchal band by 17 mm; a small accumulation of pigment below eye gives impression that nuchal band passes vertically through eye. Between 14–17 mm, 3–5 vague bars form, the anterior ones more distinct. Above 17 mm, full complement of 5 bars present (rarely 4 or 6 on one or both sides of body). Above 19 mm posterior 2–3 bars tend to become angular with their dorsal and ventral parts directed posteriorly and the lateral line extending through their apex. Above about 22 mm all the bars become irregularly distorted or wavy. By 25 mm pigmentation of caudal fin pronounced. By about 28 mm bars begin to break into the mottled or spotted pattern that lasts to over 95 mm (sometimes indistinct by 60 mm) [1] probably as an adaptation to camouflage in the *Sargassum;* [13] traces of posterior 2–3 bars persist along bases of dorsal and anal fins of some to about 48 mm. Pigmentation of all fins intensifies to over 95 mm.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Caranx crysos (Mitchill), Blue runner

ADULTS

D. VIII–I, 22–25 [1] (modally 23 [5]); A. II–I, 19–21 [1] (modally 20 [5]); C. 9+8, procurrent rays 8–9+8–9; P. 20–24 [1] (modally 22 [5]); V. I, 5; lateral line scales 86–98, the last 42–50 as scutes,[8] 46–56 scutes in straight part of lateral line in specimens larger than 100 mm; vertebrae 10+15; [3] gill rakers 10–14+23–28; branchiostegals 7; teeth comparatively large; upper jaw with an inner series of smaller teeth, a single series in lower jaw; no canines; [15] teeth present on vomer, palatines, and tongue.[6,15]

Head 3.4–5, depth 2.6 [6]–3.2,[16] pectoral 2.7–4.1 [6] in SL; snout 3 [16]–3.9,[6] eye 3.6 [6]–5.6; [16] interorbital 2.6–3.1; maxillary 2.3–2.5 [6] in head.

Body elongate, compressed; head short, snout somewhat pointed; dorsal profile rather strongly convex anteriorly; mouth oblique, terminal; [6] maxillary extending approximately to middle of eye; [5,6] supramaxillary present.[6] Anterior curve in lateral line moderately high, most scales in posterior straight part scute-like, transversely expanded, with a long keel ending in a sharp, backwardly directed point; [5] curved portion of lateral line about 1.7–2.0 in straight portion.[1] Scales small, cycloid; [6] cheek and upper part of opercle scaled, most of opercle and rest of head naked; a narrow strip on mid-back tapering backward to dorsal origin; [5] chest fully scaled.[6] Dorsal and anal fin lobes moderately produced; first dorsal shorter than second dorsal lobe; [9] pectorals falcate,[6] as long as head, barely reaching anal origin; [15] pelvics not quite reaching anus; [17] caudal broadly forked. Gill rakers somewhat longer than half eye.

Pigmentation: Color in life greenish-bronze [6] to dark black [9] above shading into bronze silvery [6] to dark gray [9] below; a more or less distinct opercular spot usually present; [6,9] spinous dorsal dusky; second dorsal, anal and caudal fins and soft part of anal fin yellowish and more or less dusky on distal parts; [6] tips of caudal fin lobes blackish; [8] pelvic fins mostly white with a tinge of yellow; pectorals plain or slightly yellowish.[6]

Sexually ripe specimens generally darker: Nearly ripe females from 247–267 mm were dark above and light below lateral line with clear pelvics and a slightly dusky anal fin; a nearly ripe male of 225 mm was black above and leaden below lateral line with all fins dark and pelvics very black.[1]

Maximum size: Largest recorded 711 mm.[9]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Halifax, Nova Scotia to Recife, Brazil,[2] including Bermuda.[9] F. H. Berry recognizes 2 geminate species, *C. fusus* in the eastern Atlantic, and *C. caballus* in the eastern Pacific. Common farther north than any other species of *Caranx*,[16] but main concentration lies within tropical waters.[2]

Area distribution: Chesapeake Bay at Ocean View, Lynnhaven Roads and Cape Charles City, Virginia; [6] Worcester County, Maryland; [14] Atlantic, Cape May, Monmouth, and Ocean counties, New Jersey.[7]

Habitat and movements: Adults—primarily in shelf and inshore waters,[2] usually in schools; [8] common July–August near Ocean City, Maryland [12] and in summer and fall in Massachusetts and New York; [10] probably move south or to warmer offshore waters of the Gulf Stream during colder months (December–June).[1] Taken in salinities from 26.0 [13]–36.2 ppt [2] and temperatures from 20–30.8 C.[2]

Larvae—found in Gulf Stream from May–November, the heaviest concentration being from mid-June to mid-August; generally taken over depths equal to or greater than 180 m. Taken in salinities from 35.2–36 ppt and temperatures from 20.4–29.4 C.[1]

Juveniles—early juveniles associated with *Sargassum* [2] in Gulf Stream to about 80 [1]–140 [4] mm above which size at least a part of the population moves inshore; [1] during summer schools extend more northward and are common off Maryland [2,12] and New Jersey. [2] Generally taken in the upper 100 m [2] near or beyond the 180 m line.[1] Taken in salinities from 35.2–36.7 ppt and temperatures from 20.4–29.4 C.[1]

SPAWNING

Location: Probably occurs offshore, the main area being south of the U.S.[1]

Season: May occur throughout year, but main spawning probably from January through August with a higher activity at the peak of summer; [2] reported to occur principally in early September in the Florida Current.[4]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

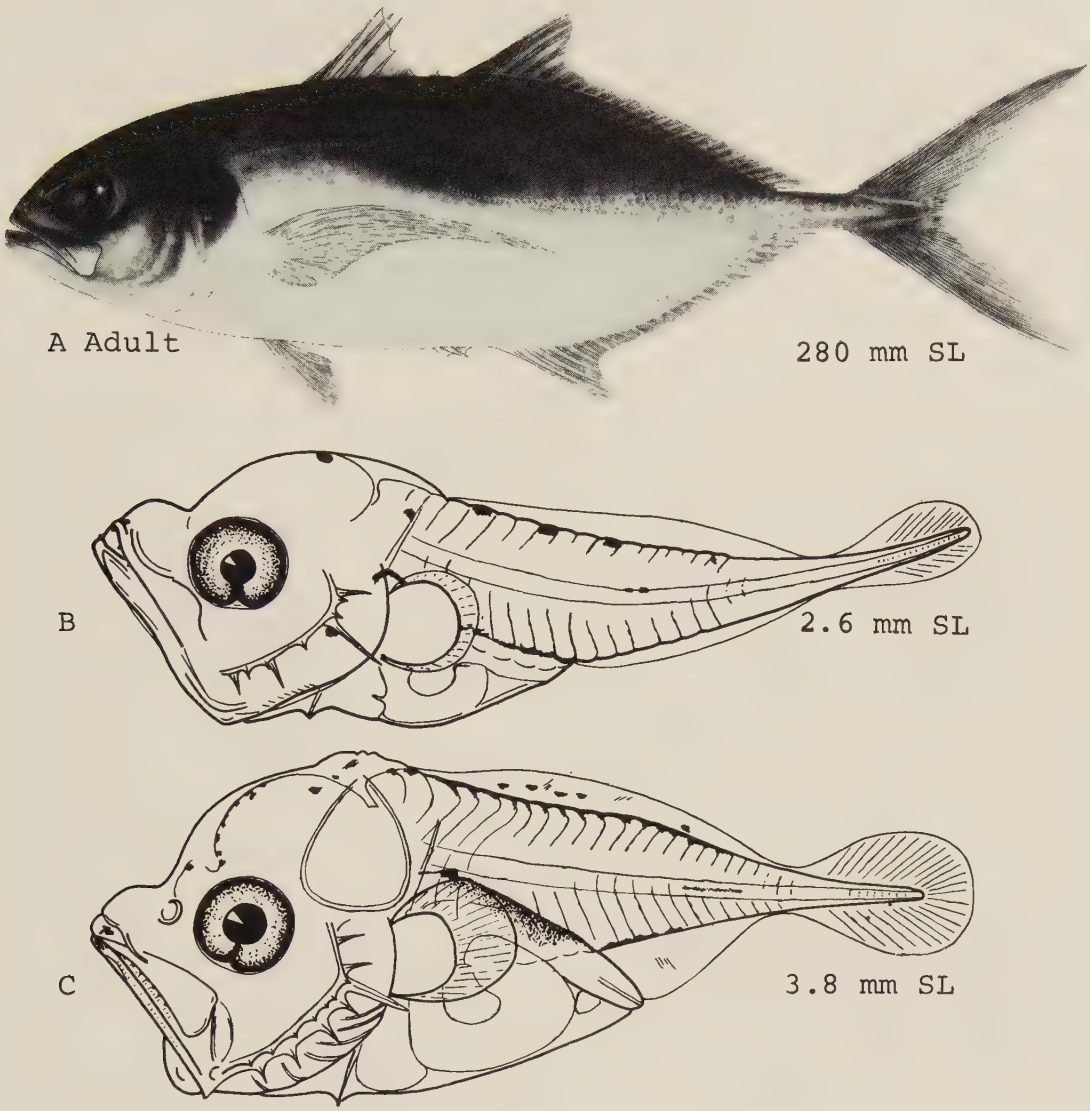

Fig. 10. *Caranx crysos,* Blue runner. A. Adult, 280 mm SL. B. Larva, 2.6 mm SL. C. Larva, 3.8 mm SL. (*A, Berry, F. H., MS. B, C, McKenney, T. W.,* et al., *1958: figs. 1 a-b.*)

LARVAE

To about 8.5 mm [1] (in some, full complement of fin rays as early as 5 mm [2]).

At 2.6 mm finfolds not very evident; at 3.8 mm higher and continuous with caudal; at 4.2 mm considerably higher, with some evidence of developing rays.[2] By 5.4 mm all dorsal spines well formed; segmentation begins by 6.5 mm; full complement of rays formed between 7.5–8.5 mm; branching of last ray occurs at 8.5 mm [1] at which point dorsal spines reach maximum relative length. By 6.1 mm procumbent dorsal spine evident.[2] Anal spines well formed by 5.4 mm, the second longer than the first; formation, segmentation, and branching of rays as in dorsal. Interneural and interhaemal spines without externally visible posterolateral projections at all sizes.[1] At 4.2 mm hypural plate has begun to form; [2] by 5.4 mm principal caudal rays all present and segmentation has begun; forking of tail has begun by 5.4 mm and is pronounced by 8 mm.[1] At 2.6 mm, pectoral prominent, largely composed of fleshy base; at 3.8 mm fleshy base relatively smaller. At 2.6 mm a portion of pelvic girdle visible just below opercle; [2] pelvics formed by 5.4 mm, but full complement of rays not evident below about 6.2 mm.[1] At 2.6 mm occipital crest not well developed; at 3.8 mm occipital crest well developed and somewhat serrate; [1] by 7 mm crest reduced [2] and serrations absent. At 2.6 mm 2 rows of spines along preopercle, the innermost row the largest and its largest spine at the pre-

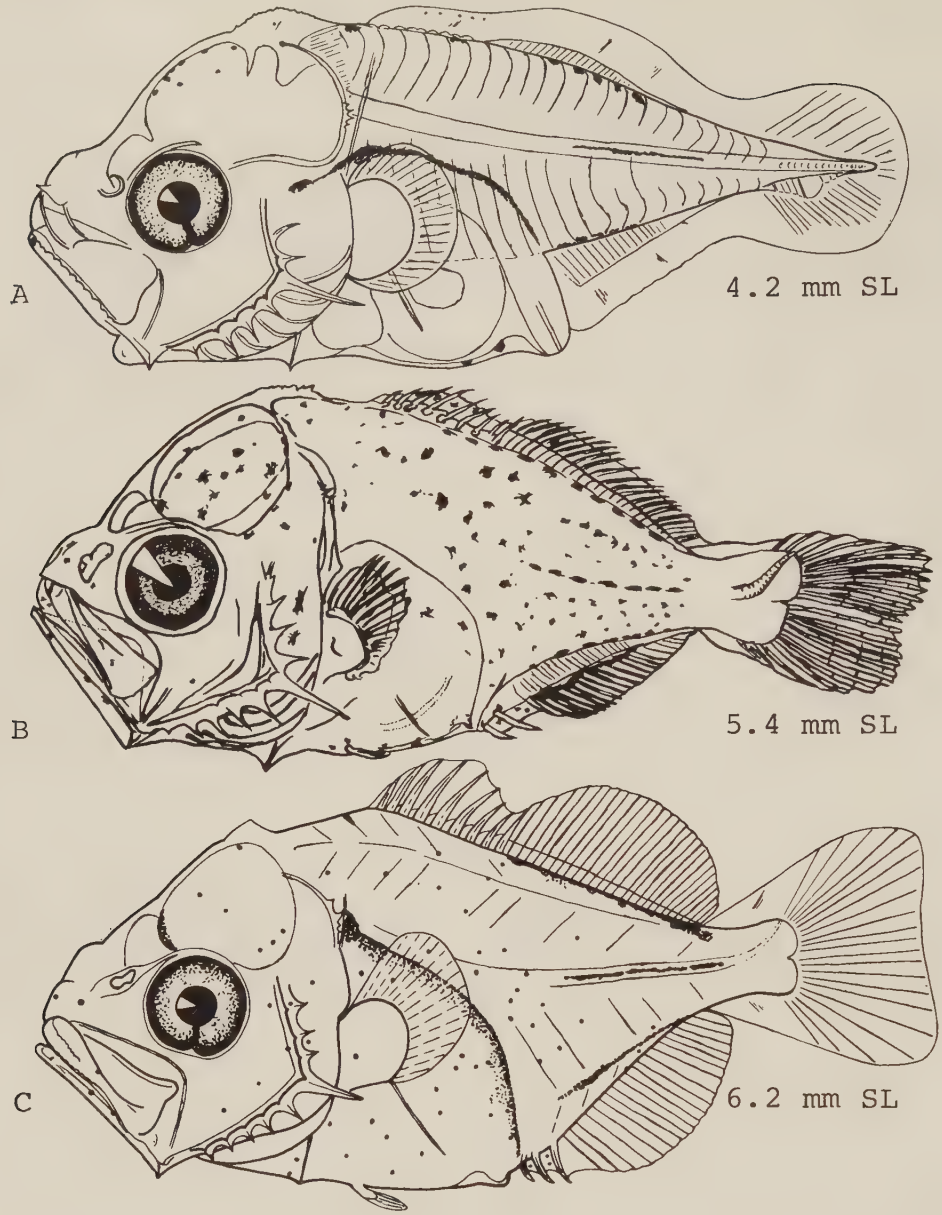

Fig. 11. *Caranx crysos*, Blue runner. A. Larva, 4.2 mm SL. B. Larva, 5.4 mm SL. C. Larva, 6.2 mm SL. (*A, C, McKenney, T. W.*, et al., *1958: figs. 1c, 2a. B, Berry, F. H., 1959: fig. 17.*)

opercular angle;[1] at 4.2 mm preopercular spines have increased to maximum size and a small patch of minute spines is present on posterior portion of head; at 6.2 mm preopercular spines slightly reduced and patch of spines on head better developed.[2] At 5.4 mm 3 posterolaterally projecting spines on cleithrum just below its junction with opercle; at 5.7–7.5 mm only 2 spines on cleithrum.[1] At 2.6 mm gut sac-like, ending in a posteriorly directed anus; at 6.2 mm anus directed ventrally and tissues over gut cavity have thickened so detail of gut no longer visible. Nostrils not present at 2.6 mm; present but not perforate at 3.8 mm; separate at 6.2 mm. At 2.6 mm mouth large, nearly vertical, a few small teeth or spikes on jaws; at 4.2 mm mouth less oblique and upper jaw with well developed serrations; at 6.2 mm serrations along upper jaw disappearing.[2]

At 2.6 mm depth 31% SL, snout 30% HL; at 3.8 mm depth 39.5 SL, snout 31.2% HL; at 4.2 mm depth 4.28 SL, snout 26% HL; at 6.2 mm depth 47% SL, snout 33.3% HL.[2]

Pigmentation: At 2.6 mm pigment present along dorsal surface of gut and dorsal part of body; pigment spots also on cranium at angle of preopercle and in region of vertebral column about halfway between head and

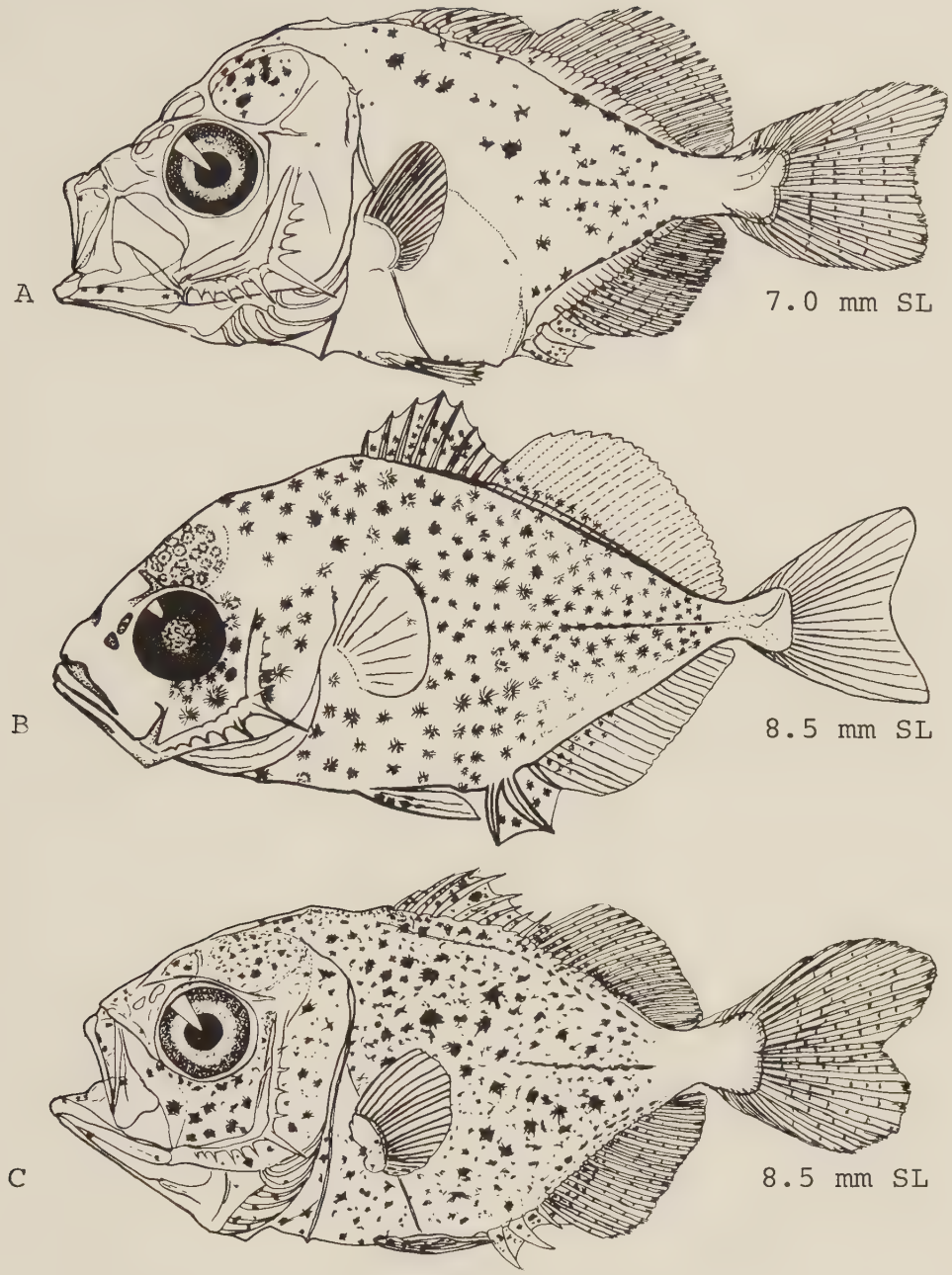

Fig. 12. *Caranx crysos,* Blue runner. A. Larva, 7.0 mm SL. B. Juvenile, 8.5 mm SL. C. Juvenile, 8.5 mm SL. (*A, C, Berry, F. H., 1959: figs. 18–19. B, McKenney, T. W.,* et al., *1958: fig. 2b.*)

caudal region. At 3.8 mm pigmentation more extensive; melanophores present on dorsal finfold and tip of snout, and an extension of pigment ventrally, posterior to anus. At 4.2 mm finfold spots barely evident and some pigment on belly; amount of pigment along vertebral column increased.[2] At 5.4 mm 3 rows of melanophores on body, below base of dorsal, above base of anal and on midline posteriorly; a few melanophores scattered over body, jaws and opercle; a group of large melanophores over eye on transparent part of braincase; a few pigment spots on interspinous membranes of dorsal and anal fins and a row of melanophores along base of anal soft rays.[1]

JUVENILES

About 8.5 mm and larger.

Extension of anterior 5–6 dorsal rays to produce lobe begins at about 14 mm; second ray averages longest to about 35 mm, first longest above 35 mm; fourth spine

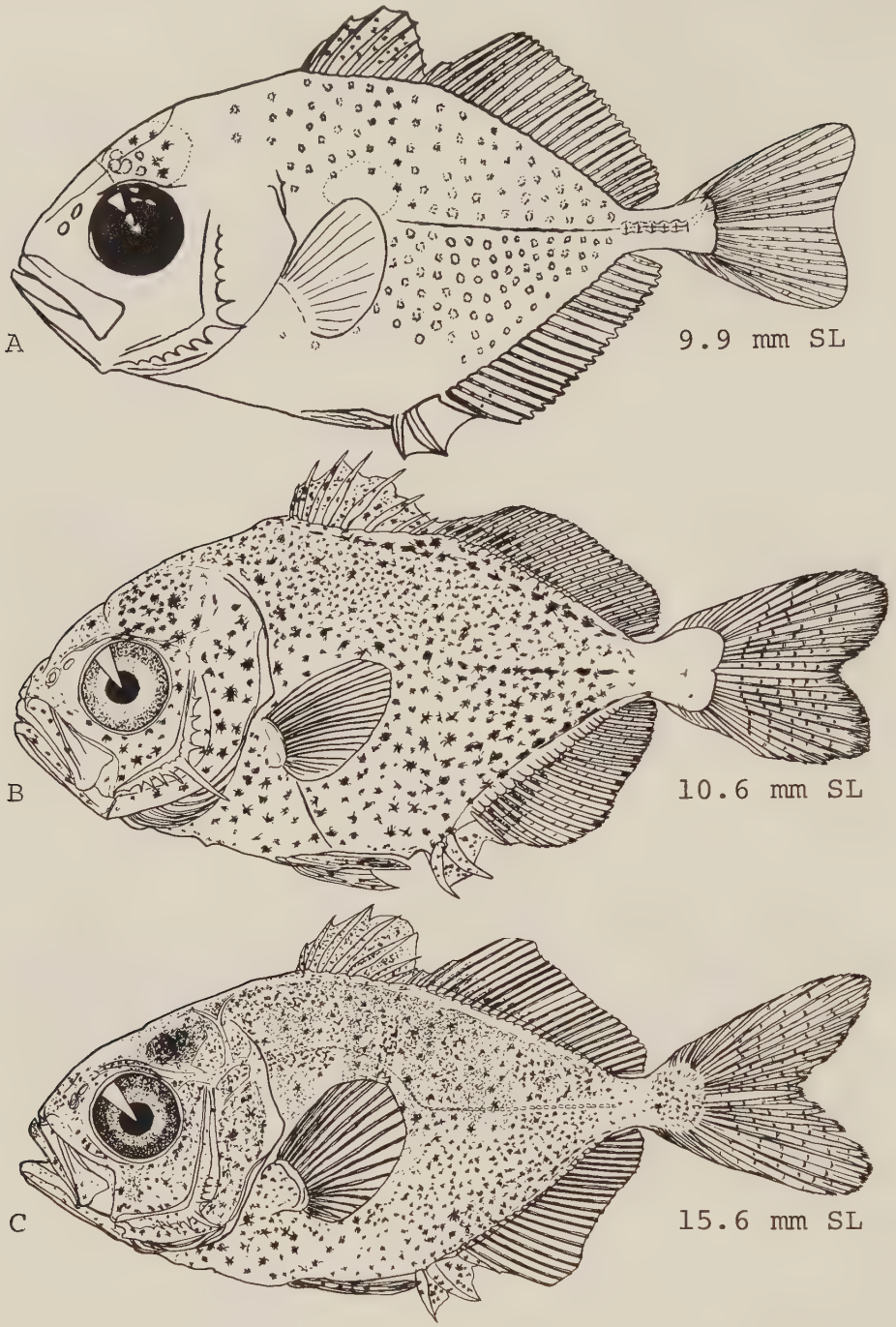

Fig. 13. *Caranx crysos*, Blue runner. A. Juvenile, 9.9 mm SL. B. Juvenile, 10.6 mm SL. C. Juvenile, 15.6 mm SL. (*A, McKenney, T. W.*, et al., *1958: fig. 2c. B, C, Berry, F. H., 1959: figs. 20–21.*)

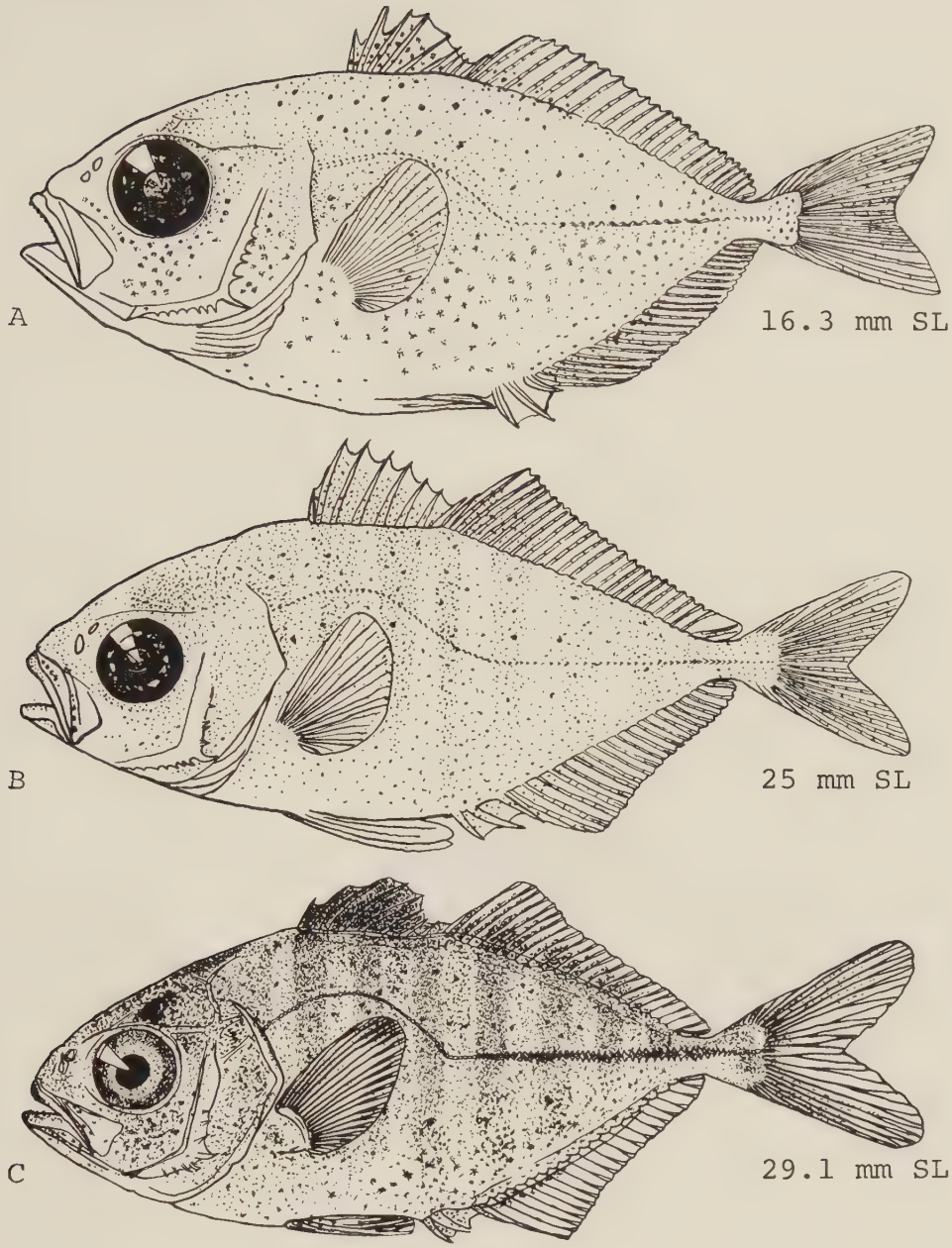

Fig. 14. *Caranx crysos*, Blue runner. A. Juvenile, 16.3 mm SL. B. Juvenile, 25 mm SL. C. Juvenile, 29.1 mm SL. (*A, B, McKenney, T. W.*, et al., *1958: figs. 3 a-b. C, Berry, F. H., 1959: fig. 22.*)

longest to about 37 mm, third longest above 37 mm. Interspinous membrane connects eighth and ninth dorsal spines to about 90 mm.[1] Procumbent dorsal spine with well developed anterior projection by 8.7 mm.[2] Second anal ray averages longest to about 22 mm, first longest above 22 mm; [1] by 38 mm anterior 2 anal spines separate from remaining fin.[2] Interspinous membrane connects second and third anal spines to about 45 mm.[1] At 8.5 mm caudal peduncle well differentiated [2] and full complement of procurrent caudal rays present; urostyle visible to about 9 mm; branching begins at 10 mm and is pronounced by 15 mm; [1] by 135 mm 2 keels present on caudal peduncle above and below scutes.[2] Full complement of pectoral rays present by 8.5 mm; branching begins by 25 mm; falcation begins at about 35 mm and is pronounced by 100 mm.[1] At 8.5 mm pelvics extend to anus; [2] branching begins by 15 mm.[1] At 8.5 mm preopercular spines relatively shorter and head spines almost gone; by 38.3 mm both have almost disappeared.[2] Cleithral spines absent by 8.5 mm.[1] At 8.5 mm serrations on upper jaw absent; at about 10 mm mouth has assumed approximate angle of adult. At 59.3 mm

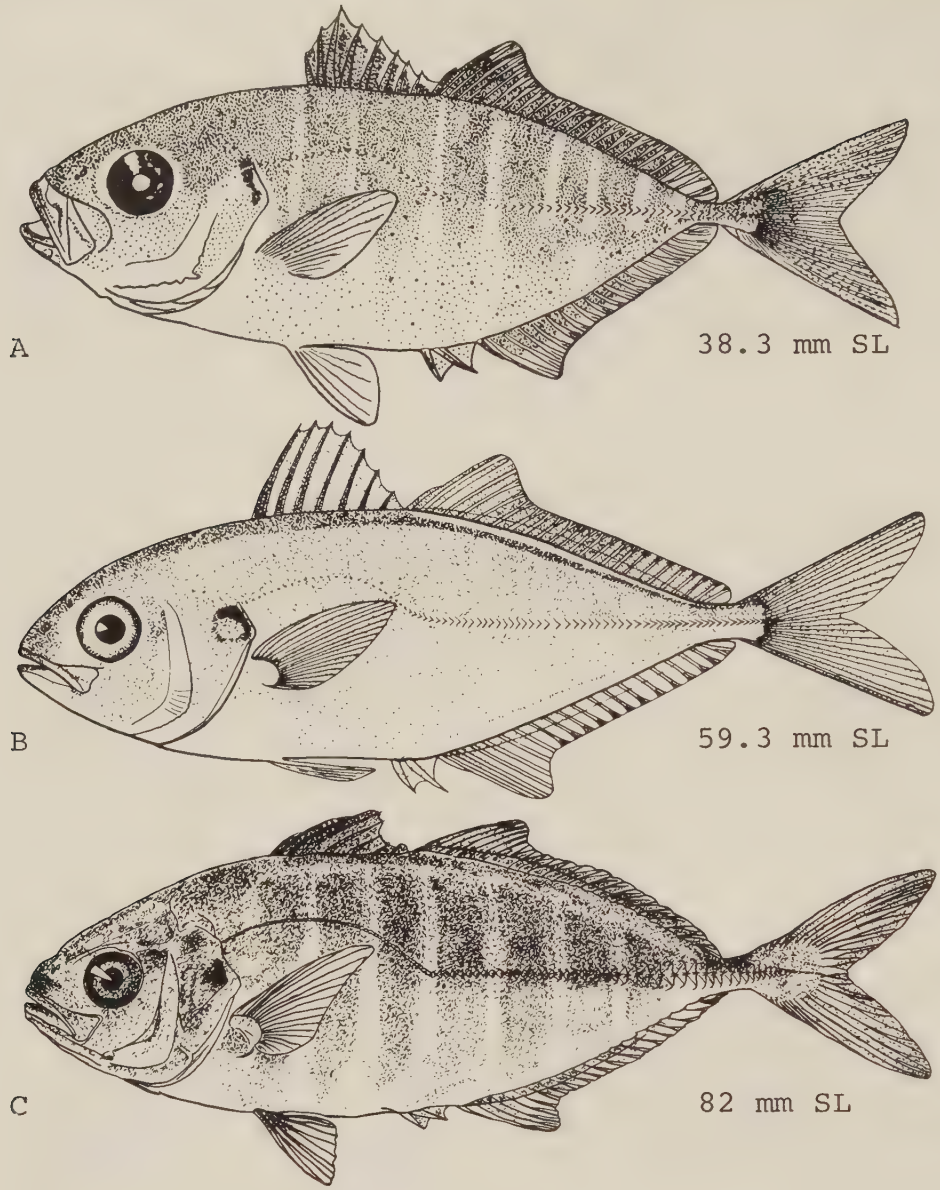

Fig. 15. *Caranx crysos*, Blue runner. A. Juvenile, 38.3 mm SL. B. Juvenile, 59.3 mm SL. C. Juvenile, 82 mm SL. (*A, B, McKenney, T. W.*, et al., *1958: figs. 3c, 4a. C, Berry, F. H., 1959: fig. 23.*)

essentially all characteristics of adult present.[2]

At 9.8 mm no scales present; at 10.4 mm scales present along straight part of lateral line; at 13.1 mm entire lateral line scaled; at 14.4 mm a single row of scales present above and below straight part of lateral line; at 16.0 mm scales in row above lateral line have developed circuli; at 18.3 mm body covered with scales except small area anterior to first dorsal and pectorals, on chest and on end of caudal base, also a basal scale sheath present at base of dorsal and anal; at 19.6 mm straight part of lateral line has extended onto caudal fin; at 23.3 mm scales have essentially covered body; at 30.4 mm scales present on head behind and below eye and on posterior part of head; at 43.5 mm scale rows formed on membranes between anterior dorsal and anal soft rays; at 70.5 mm scales starting to form on pectorals and pelvics; at 177 mm squamation as in adult.[18]

At 9.9 mm depth 52.6% SL; at 38.3 mm depth 36.4% SL; at about 60 mm depth about 32% SL.[2]

Pigmentation: At 8.5 mm chromatophores cover all areas except snout, caudal peduncle and fins, but some slight pigmentation on dorsal, anal and pelvics. At 9.9 mm ventral pigment somewhat reduced.[2] Between 10–15

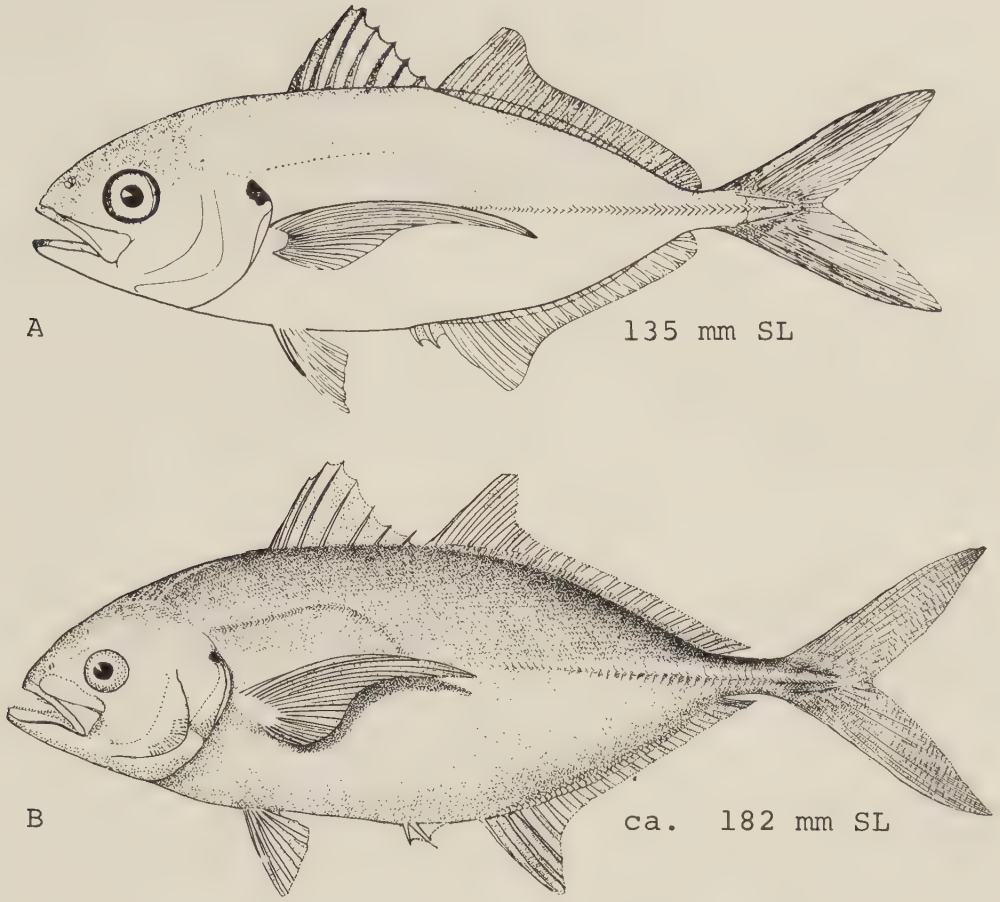

Fig. 16. *Caranx crysos,* Blue runner. A. Juvenile, 135 mm SL. B. Juvenile, ca. 182 mm SL. (*A, McKenney, T. W.,* et al., *1958: fig. 46. B, Goode, G. B., 1884: pl. 101.)*

mm braincase becomes opaque. By 12 mm the 3 rows of elongate melanophores which were evident at 5.4 mm begin to intergrade with other body pigmentation.[1] At 16 mm there is a concentration of pigment dorsally on body and additional pigment on dorsals, second anal, caudal and pectorals.[2] Between 15–19 mm body bars begin to form and number of bars increases to normal complement of 7 by 23 [1]–25 mm, these bands tending to run together and become less distinct posteriorly; [2] bars sometimes retained to over 100 mm.[1] Between 25–38.3 mm a black spot appears on upper limb of opercle.[2] At about 28 mm a dense mass of pigment begins to develop on upper portion of caudal peduncle. By about 29 mm pigment on braincase has changed from a few large melanophores to a pigment mass which is projected posterodorsally to form a nuchal band; concentration of pigment on and below eye gives impression that nuchal band bends downward and continues through eye. Between about 30–40 mm a vertically elongate spot forms on opercle, becomes prominent at about 60 mm and is reduced and located at upper margin of opercle by about 100 mm. Pigment on first dorsal intensifies to about 82 mm and then diminishes.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

Males mature at least by 225 mm and females by 247 mm.[1]

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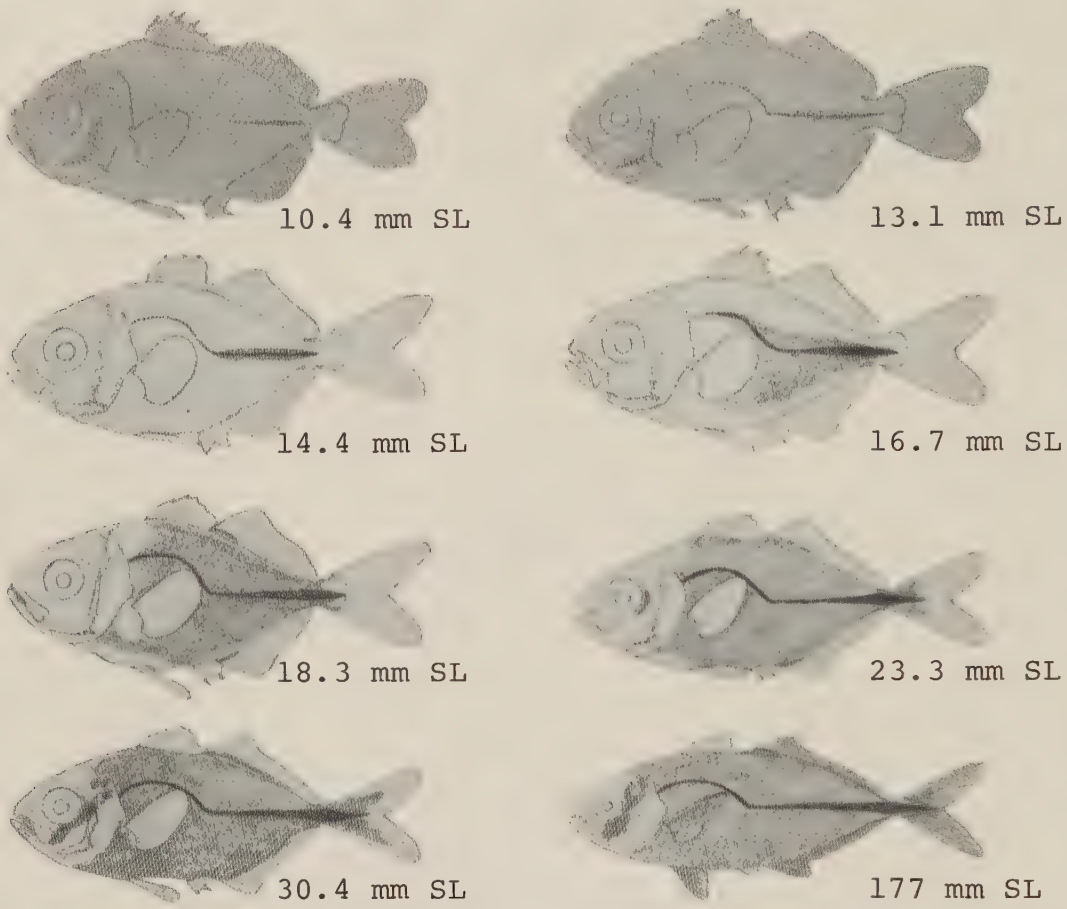

Fig. 17. *Caranx crysos,* Blue runner. General sequence of appearance and development of scales. Black areas represent scales and scutes in the lateral line. Shaded areas represent scales of the body, fins and head. (*Berry, F. H., 1960: fig.* 2.)

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Caranx hippos (Linnaeus), Crevalle jack

ADULTS

D. VIII–I, 18–21 [18] (modally 20 [6]), the posterior 1 to 4 spines separated and covered by skin in specimens larger than about 450 mm; [18] A. II–I, 15–17 (modally 16 [6]); C. 9+8, procurrent rays 8–9+8; [1] P. 20–21; [6] V. I, 5; [1] lateral line scutes 25–42 [14] (only up to 35 in western Atlantic specimens [18]), lowest counts generally found in largest specimens due to loss of posterior spines with growth; [1] vertebrae 10+14; [11] gill rakers 6–9+16–19; branchiostegals 7; [1] teeth in upper jaw in a broad villiform band, with an outer series of large wide-set conical teeth; teeth of lower jaw in one row with a distinct canine on each side of symphysis; vomer, palatines and tongue with villiform teeth.[19]

Head 3.3–3.7, depth 2.2–2.5, pectoral 2.9–3.4 in SL; snout 3.6–4.5, eye 3.3–4.2, interorbital 2.9–3.6, maxillary 2.1–2.4 in head.[10]

Anterior profile very steep, making a strongly convex curve; [6] head large, snout blunt; mouth oblique, terminal; [10] maxillary ending under posterior margin of eye; [6] supramaxillary present. Scales small; cheek and upper part of opercle scaled, most of opercle and rest of head scaleless; a narrow naked strip on mid-back tapering backward to dorsal origin; [6] a large area in front of pelvic base and below pectoral base scaleless, except a small patch of scales on ventral aspect, directly in front of pelvic base.[10] Anterior curve in lateral line moderately high, most scales in posterior straight part of lateral line scute-like, transversely expanded, with a long keel ending in a sharp, backwardly directed point; [6] curved portion 1.1–1.5 in straight portion,[1] anterior 3–10 scales in straight portion not definitely scute-like.[6] Dorsals well separated; soft dorsal and anal with high lobes; [6] pectorals long and falcate; caudal broadly forked.[10] Gill rakers about half length of eye.[1]

Pigmentation: Color in life bluish green or greenish bronze above; lower parts pale silvery, sometimes with yellow blotches; a distinct black spot on opercle; fins usually yellowish; spinous dorsal and elevated portion of soft dorsal distally dusky; pelvics partly white; [10] smaller specimens often with a large black spot on pectoral near its lower posterior margin, developed on interradial membranes but not extending onto rays; an inner black spot at upper pectoral angle.[6] Diagnostic markings are the brightness of the yellow parts, large black blotch on opercle, and especially the black spot on lower pectoral ray membranes.[17]

Maximum size: Largest recorded 980 mm, may reach 1500 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Nova Scotia[5] to Uruguay,[1] primarily in shallow continental waters; one record only from Bahamas (FHB), some other records exist from the West Indies where it is probably uncommon (FHB, FDM). Relatively more common in northern part of range.[14]

Area distribution: Chesapeake Bay at Yorktown, Lynnhaven Roads and Ocean View, Virginia; [10] Eastern Shore, Virginia; [12] Atlantic, Monmouth, Ocean counties, New Jersey.[9]

Habitat and movements: Adults—occur in inshore and even brackish waters,[1] frequently being taken upstream in coastal rivers; probably most common in shallow flats but large fish are taken from deeper offshore waters;

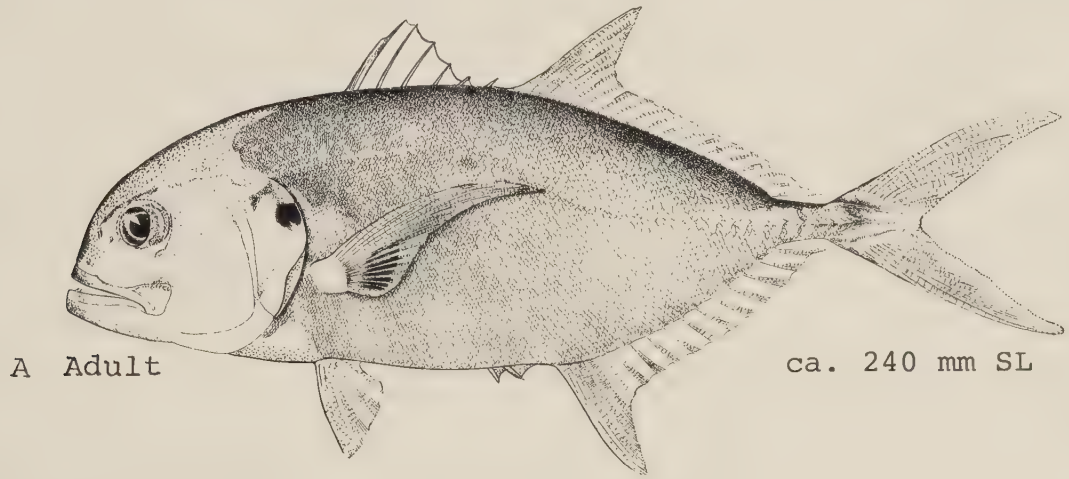

Fig. 18. *Caranx hippos,* Crevalle jack. A. Adult, ca. 240 mm SL. (*A, Goode, G. B., 1884: pl. 99.*)

usually a schooling species, the larger fish tending to become solitary; [18] second most common *Caranx* in inshore waters along the Atlantic coast of the U.S.; [1] common in schools off Maryland from July to September.[16] Taken in salinities ranging from fresh water [8] to 43.8 ppt,[2] but most common in salinities higher than 30.0 ppt; [7] taken at temperatures ranging from 18–33.6 C.[2]

Larvae—pelagic, probably associated with offshore currents; probably migrate to the south or warmer offshore waters during colder months (December–March). Taken in salinities from 35.2–36.7 ppt and temperatures from 20.4–29.4 C.[1]

Juveniles—probably migrates inshore during early juvenile stage; [1] not uncommon in shallow brackish water in schools; [14] common in Massachusetts and New York from July to October,[15] probably spending colder months offshore or to the south.[1] Taken in salinities at least as low as 0.5 ppt as far north as Massachusetts; lower lethal temperature around 7.4–9.0 C.[3]

SPAWNING

Location: Probably occurs offshore [1] and primarily to the south of the Florida Straights.[13]

Season: March–September in the western Atlantic.[1]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

About 8.0 mm and larger.

Depth at first anal spine averages less than depth at pelvic from 15.3 mm to about 30 mm, is about equal from 30–90 mm and is greater above 90 mm. Posterior dorsal rays branched at 15.3 mm; extension of anterior 5 rays to produce lobe has begun by 25 mm and is advanced by 80.5 mm; second ray averages longest to about 27 mm, first is longest above 27 mm; second spine averages greater length than longest soft ray to about 34 mm, ray longer above 34 mm. Interspinous membrane between eighth and ninth dorsal spines lost at about 80 mm; membrane between seventh and eighth spines lost at about 120 mm. Anal fin branching and lobation as in dorsal; first spine averages longer than second from 15.3–20.4 mm, second spine longer above 23 mm; first and second rays longest to about 32 mm, first longest above 32 mm. Interspinous membrane between second and third anal spines lost at about 25 mm. At 12.7 mm, interneural and interhaemal spines with well developed posterolateral projections extending above body surface along bases of dorsal and anal soft rays; these projections still visible at 164 mm, but absent by 248 mm. Principal caudal rays branched by 15.3 mm. Pectoral with full complement of rays by 20.4 mm; distal end of pectoral rounded by 27 mm, falcation pronounced by 80.5 mm. Pelvic soft rays branched and segmented by 15.3 mm. At 25 mm a small patch of scales apparent on chest just in front of pelvics; by 80.5 mm a patch of scales present along each cleithrum and laterally along insertion of each pelvic fin. At 16.1 mm a few scutes completely developed; by 100 mm nearly all scutes completely developed. From 12.7–22.1 mm 3–6 spines present on lower limb of preopercle; actual size at loss of preopercular spines varies somewhat and may be associated with movement into inshore waters.[1]

Pigmentation: At 15.3 mm 3 vertical bars on body, fourth and fifth bars present as an undivided pigment mass; some pigment above eye over brain and on upper portion of opercle; first dorsal densely pigmented to eighth spine; pigment spots present on anal spines and their interspinous membranes and on pelvics, other fins unpigmented. At 16.3 mm 5 bars on body; bars slightly wider than interspaces, extending nearly to base of anal fin to about 60 mm, shorter above this size. Above 20 mm pelvics unpigmented. Between 20–30 mm pigment area over eye elongates posteriorly to form nuchal band; a pigment area below eye suggests a bending and continuation of nuchal band through eye; massing of pigment of opercle forms opercular spot. At 30 mm pigmentation of caudal rays develops; pigmented area develops on top of caudal peduncle and is very dark above 100 mm; pigmentation on first dorsal decreases. Above 35 mm anal soft rays and membranes are pigmented and the pigment spots of the anal spines and their membranes disappear. By 40–50 mm pigment appears on second dorsal and migrates to edge of fin along ninth spine and tips of soft rays. At about 120–140 mm a pectoral spot develops midway along lower rays.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

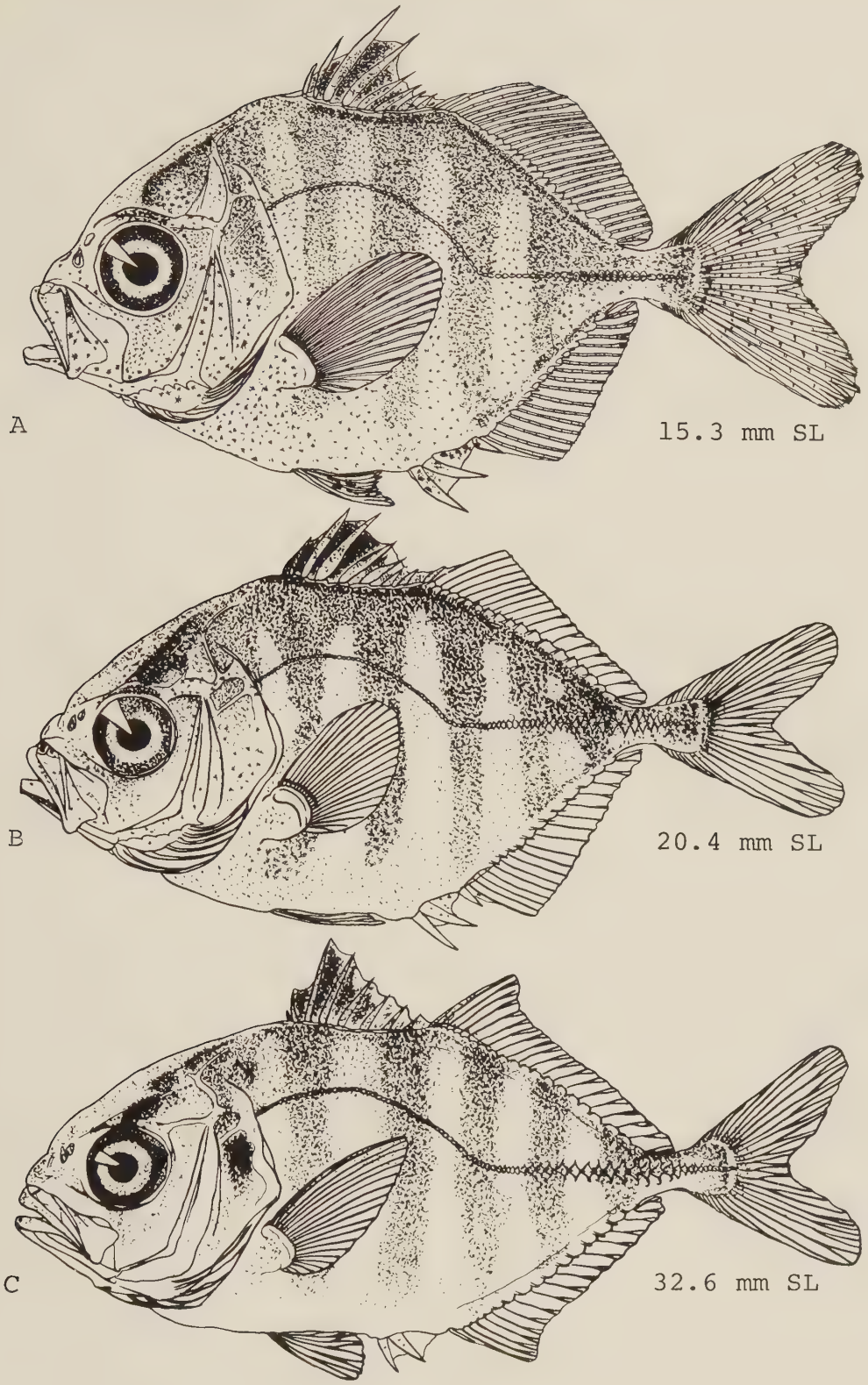

Fig. 19. *Caranx hippos*, Crevalle jack. A. Juvenile, 15.3 mm SL. B. Juvenile, 20.4 mm SL. C. Juvenile, 32.6 mm SL. (*Berry, F. H., 1959: figs. 81–83.*)

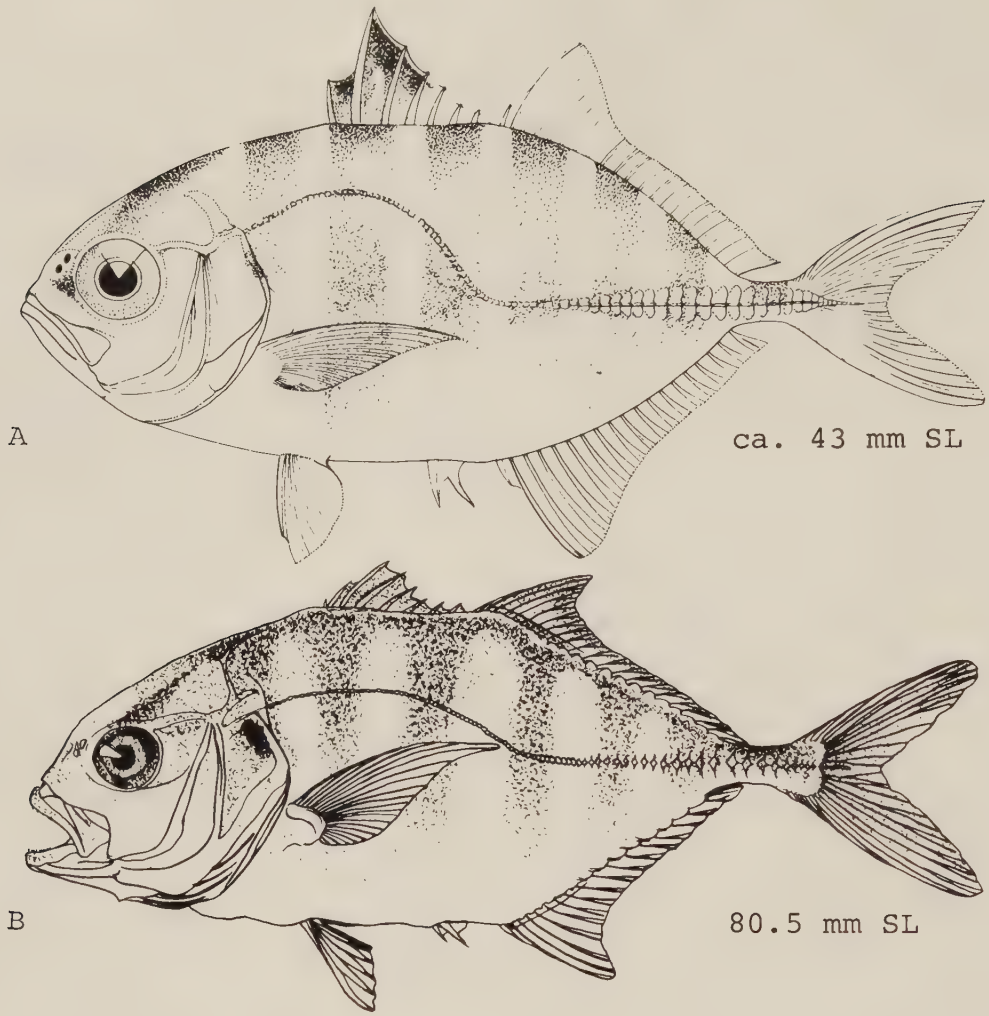

Fig. 20. *Caranx hippos,* Crevalle jack. A. Juvenile, ca. 43 mm SL. B. Juvenile, 80.5 mm SL. (*A, Fowler, H. W., 1936: fig. 312. B, Berry, F. H., 1959: fig. 84.*)

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Caranx latus Agassiz, Horse-eye jack

ADULTS

D. VIII–I, 19–22[1] (modally 21 [3]); A. II–I,[1] 15 [2]–18 [1] (usually 17 [3]); C. 9+8, procurrent rays 8–9+8; [1,11] P. 18 [2]–21; [1,2,3] V. I, 5; [1] lateral line scales 84–92, 30–50 lateral line scutes,[9] 32–39 in straight part; [4] vertebrae 10+14; [2,11] gill rakers 6–7+16–18; branchiostegals 7; [1] teeth comparatively large, a single series in lower jaw; upper jaw with an inner series of smaller teeth; no canines; [10] teeth present on vomer, palatines and tongue.[10,16]

Head 3.3 [13]–3.6, depth 2.2 [10]–2.7,[13] pectoral 3.0 in SL; snout 3.4 [10]–3.5,[13] eye 3.8 [10]–4.0, interorbital 3.2 [13]–3.3; [10] maxillary 2.1 in head.[10,13]

Body moderately deep; [4] anterior profile rising steeply and making a rather gradual curve; [3] head large, snout blunt,[10] profile convex; [4] mouth oblique, terminal,[10] maxillary ending under posterior margin of eye or nearly so; [3] supramaxillary present.[10] Anterior curve in lateral line moderately high, most scales in posterior straight part scute-like, transversely expanded, with a long keel ending in a sharp, backwardly directed point; [3] curved portion 1.4–2 in straight portion.[1] Scales small, cycloid; [10] cheek and upper part of opercle scaled, most of opercle and rest of head scaleless; a narrow scaleless strip on mid-back tapering backward to dorsal origin; [3] chest completely scaled.[1] Dorsal and anal fin lobes high, the fins moderately scaled; [3] pectoral fins long and falcate; caudal broadly forked. Gill rakers a little longer than half eye.[10]

Pigmentation: Color in life dark gray above, silvery on sides, white on belly; dull greenish and slightly brassy reflections on back and sides, bluish, pinkish, and greenish ones on lower parts; a small dusky mark at extreme upper end of gill opening; tip of scutes dusky, making a conspicuous dusky streak in center of tail region; spinous dorsal pale, soft dorsal light gray, caudal grayish yellow; end of dorsal lobe and margin of caudal black; anal gray, anterior rays, distal end of lobe and very narrow basal and marginal line whitish; pectoral pale; pelvics white; tip of lower jaw dusky. Diagnostic markings are the dusky line along tip of scutes and the small dark mark at upper end of gill opening.[15]

Maximum size: Largest recorded 760 mm.[9]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from New Jersey to Rio de Janeiro, Brazil [1] including Bermuda.[9]

Area distribution: Ocean View, Virginia; [10] Ocean County, New Jersey.[8]

Habitat and movements: Adults—occur in small schools around islands and offshore islands and along sandy beaches in the tropics; occasionally taken in coastal fresh water rivers and streams; [4] occur seasonally, but not abundantly on the Atlantic coast of the U.S., probably migrating southward or to warmer offshore waters during colder months.[1]

Larvae—probably associated with offshore currents. Taken in salinities from 35.2–36.7 ppt and temperatures from 20.4–29.4 C.[1]

Juveniles—probably associated with offshore currents to 16–20 mm when they migrate inshore [1] where they are characteristic of shallow brackish regions with mud bottoms [9] and occasionally penetrate freshwater.[5,6,9] Taken in salinities from 12.1 [12]–36.7 [1] ppt and temperatures from 20.0 [12]–22.2 C.[1]

SPAWNING

Location: Probably occurs offshore,[1] the major area being south of the Florida Straits.[1,14]

Season: Estimated to occur from March–July off the southeast U.S.; smallest specimen taken off Florida in June; [1] ripe individuals taken in Puerto Rico in June.[7]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

Note: *The identity of the larvae described in the following section is not certain but these specimens were assigned by Berry (1959) to either* C. latus *or* C. hippos *and are described here under* C. latus *for convenience.*

LARVAE

To about 8 mm.

By 5.4 mm dorsal spines well formed; from 5.4–6.1 mm third and fourth spines longest; from 6.2–8.3 mm the third longest; at 6.9 mm 20 soft rays evident, 21 at 8.3 mm. Anal spines well formed; from 5.4–6.3 mm second spine longest; from 6.9–8.3 mm first longest; at 6.3 mm soft rays not formed; at 6.9 mm 16 soft rays evident, 18 at 8.3 mm. At 6.9 mm principal caudal rays 9+8, pro-

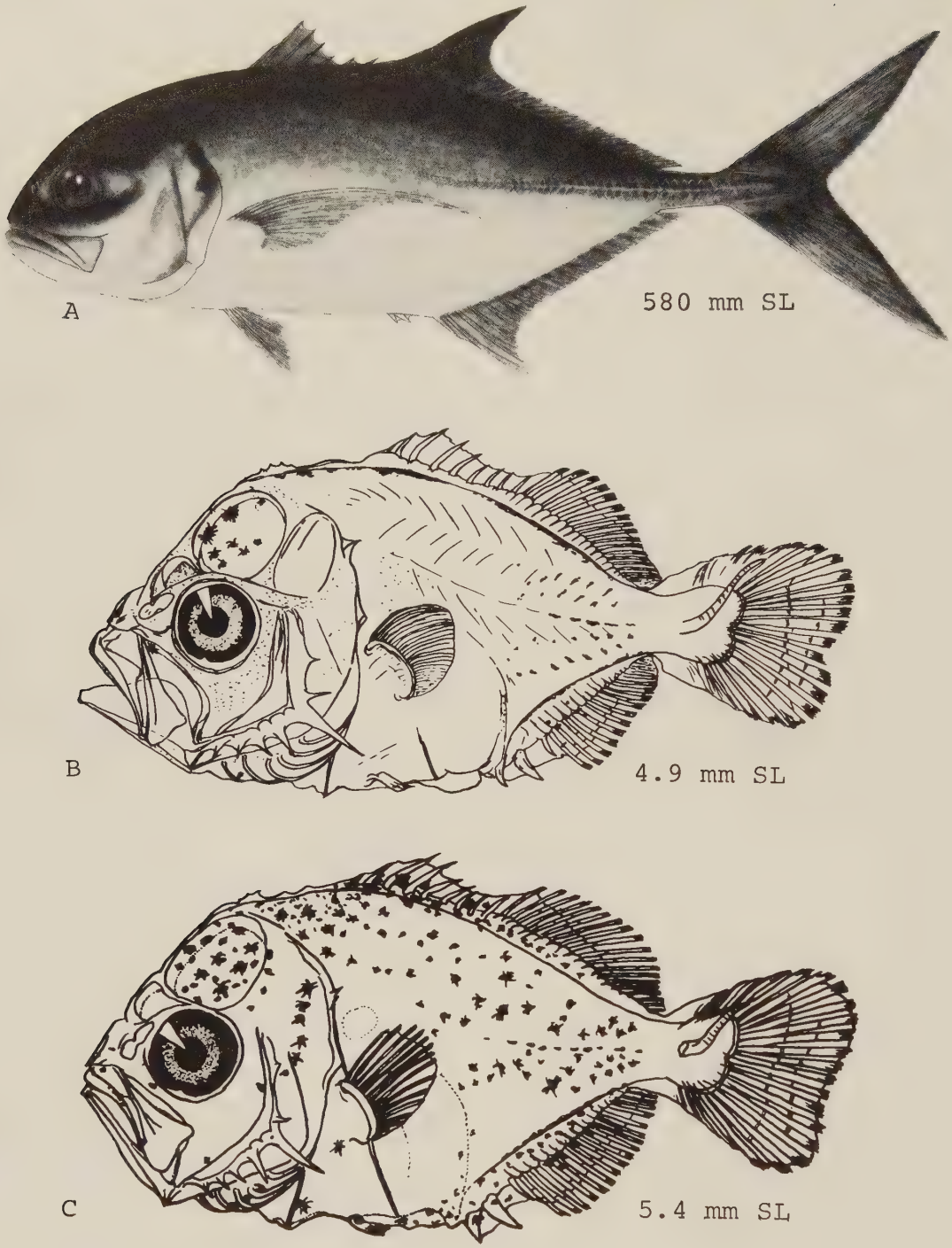

Fig. 21. *Caranx latus,* Horse-eye jack. A. Adult 580 mm SL. B. Larva (*latus* or *hippos*), 4.9 mm SL. C. Larva (*latus* or *hippos*), 5.4 mm SL. (*A, Berry, F. H., MS. B, C, Berry, F. H., 1959: figs. 64–65.*)

Fig. 22. *Caranx latus* or *hippos* (not distinguishable at this size). A. Larva, 6.2 mm SL. B. Larva, 6.9 mm SL. C. Juvenile, 8.3 mm SL. (*Berry, F. H., 1959: figs. 66–68.*)

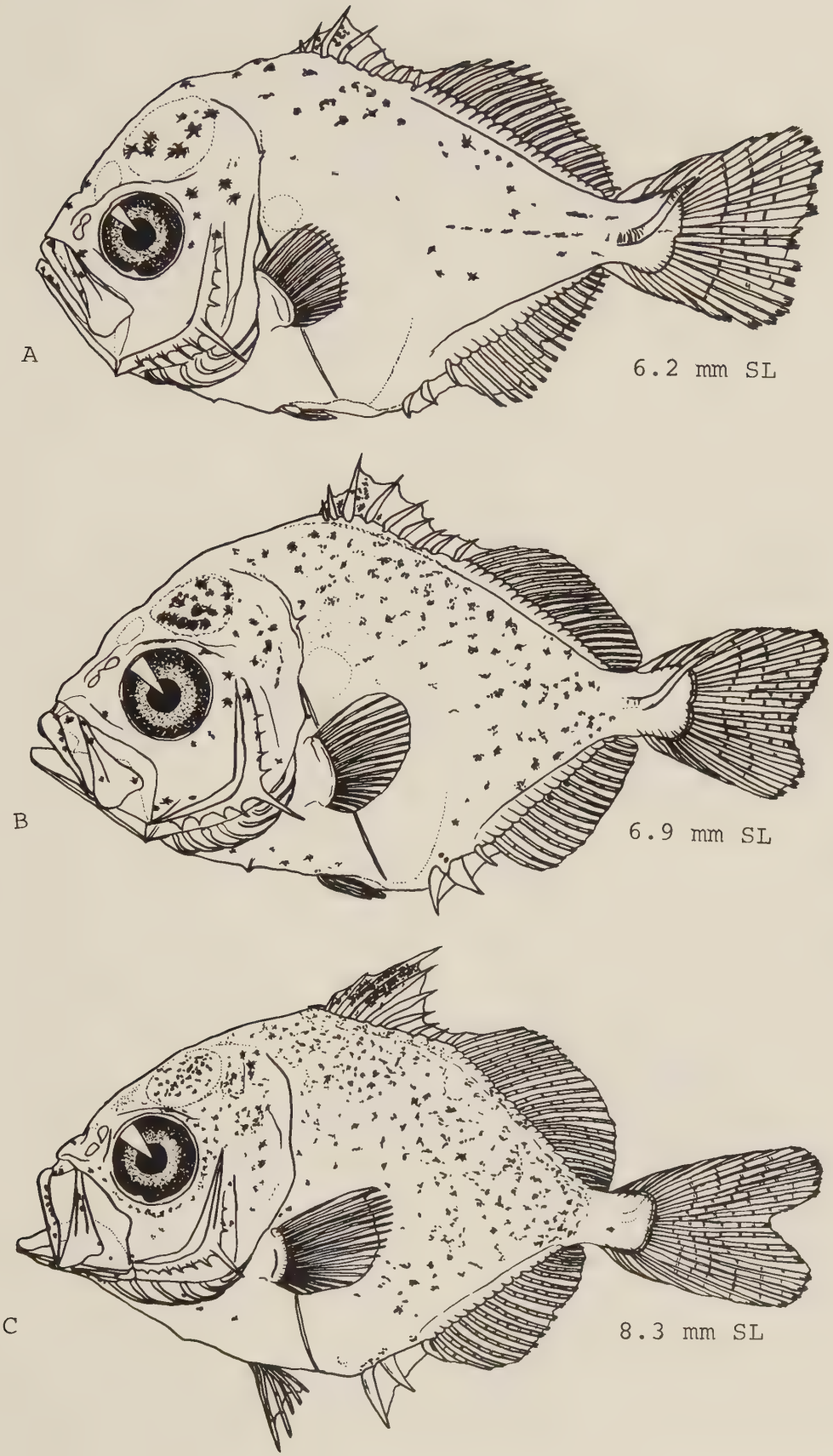
A
6.2 mm SL
B
6.9 mm SL
C
8.3 mm SL

Fig. 23. *Caranx latus*, Horse-eye jack. A. Juvenile, 16.1 mm SL. B. Juvenile, 21.8 mm SL. C. Juvenile, 31.9 mm SL. (*Berry, F. H., 1959: figs. 69–71.*)

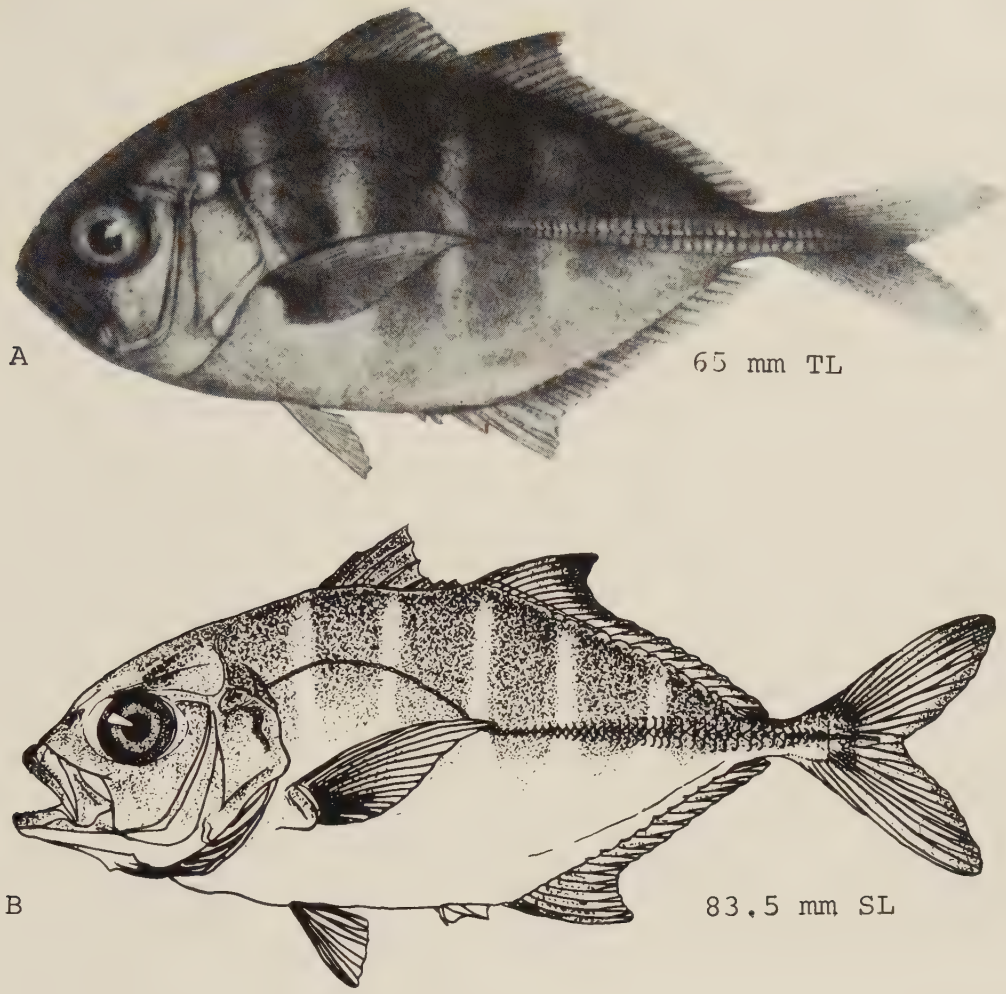

Fig. 24. *Caranx latus,* Horse-eye jack. A. Juvenile, 65 mm TL. B. Juvenile, 83.5 mm SL. (*A, Meek, S. E., and S. F. Hildebrand, 1925: pl. 26, fig. 1. B, Berry, F. H., 1959: fig. 72.*)

current rays 6+6; by 8.3 mm procurrent rays 8+8; at 5.4 mm segmentation of rays has begun and there is a slight indentation in the posterior margin of the fin; at 8.3 mm no branching of the rays is yet evident, and the indentation of the fin is pronounced. At 8.3 mm full complement of pectoral rays present, but not at 6.9 mm. At 6.9 mm full complement of pelvic rays present, but not at 5.4 mm; segmentation has begun by 8.3 mm. Lateral line not developed by 8.3 mm. Between 5.4–8.3 mm well developed spine at preopercular angle decreases in length. Below 8.3 mm a single posterolaterally projecting spine on cleithrum just below its junction with opercle. At 5.7 mm supraorbital crest with serrated edge, lost above 6.2 mm. Nostril completely divided by 8.3 mm.[1]

Pigmentation: At 5.4 mm 3 pigment spots on anal spine membrane; a few melanophores on interspinous membrane of first dorsal increasing in number to 8.3 mm and becoming associated with first 4 spines. From 5.4–8.3 mm a row of elongate melanophores on midline posteriorly, absent by 6.9 mm. From 5.4–8.3 mm scattered pigment spots on body and larger melanophores over brain case increase in number.[1]

JUVENILES

About 8 mm and larger.

Depth at first anal spine averages less than depth at pelvic from 16.1–30 mm, is equal from 30–50 mm and greatest above 50 mm. At 16.1 mm posterior soft dorsal rays begin to branch; extension of anterior 5–6 soft rays to produce lobe by 31.9 mm; below 34 mm second ray averages greatest length, above 34 mm first ray longest; below 50 mm third spine averages longer than first soft ray, above 50 mm soft ray longer; interspinous membrane connects eighth and ninth spines to about 75 mm. At 16.1 mm only ultimate anal soft ray branched; second soft ray longest to 21.8 mm, first and second rays equal and longest at 34.4 mm, first ray longest above 36.5 mm; longest anal ray shorter than longest dorsal at 16.1 mm,

equal between 21.8–34.1 mm, shorter above 34.1 mm. At 16.1 mm interneural and interhaemal spines with well developed posterolateral projections extending above body surface along bases of dorsal and anal soft rays; these projections externally visible to 156 mm; at 172 mm those of dorsal covered by fleshy sheath covering base of rays but 6 along anal base remain exposed. Branching of caudal rays has occurred by 16.1 mm. Full complement of pectoral rays present by 16.1 mm; distal end of pectorals rounded to about 32 mm after which they became pointed and falcation begins; falcation pronounced by 65 mm. Pelvic rays branched and segmented by 16.1 mm. Some scute development evident by 16.1 mm. At 45 mm 2–5 rudimentary gill rakers at origin of upper limb; at 60 mm 1–3 rudimentary gill rakers on lower limb. Preopercular spines present at 13 mm, disappearing between 16–20 mm.[1]

Pigmentation: At 16.1 mm 5 dark bars present on body, posterior 3 extending to base of anal fin; a heavily pigmented area on braincase above eye and less heavily pigmented areas on upper portion of opercle and fleshy part of tail; first dorsal, pelvic and interspinous membranes of anal with pigment spots, remaining fins unpigmented. At about 20 mm last 3 bars terminate just below lateral line. At 21.8 mm pigment on first dorsal more intense and largely restricted to membranes connecting second, third and fourth spines. At 26 mm and above body bars wider than interspaces. At 31.9 mm and above anal spine membranes and pelvic fins unpigmented and second dorsal and caudal have pigment at bases. By 40–60 mm pigment intensifies and migrates to edge of dorsal and becomes concentrated on dista half of dorsal lobe. Between 90–116 mm bars disappear.

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Chloroscombrus chrysurus (Linnaeus), Atlantic bumper

ADULTS

D. VIII–I, 26–28 [7,10] (modally 27 [10]); A. II–I, 25–27 [7,10] (usually 26 or 27 [10]); C. 9+8, procurrent rays 8–9+7–9; [17] P. 10–20 (predominantly 19 [10]); V. I, 5; [9] 61–68 total scales in straight lateral line, 7–12 modified as scutes; [7,10] vertebrae 10+14; [17] gill rakers 9–11+31–35; [7,10] teeth small, in narrow bands in jaws and on palatines, except in 2 irregular rows on sides of lower jaw; teeth in a medium patch on vomer and covering most of tongue.[10]

Depth 2.1–2.4, head 3.6–4.3, pectoral 2.9–3.6 in SL; snout 3.3–4.0, eye 2.6–3.2, maxillary 2.4–2.7 [9] in head.

Body ovate, strongly compressed; [9] ventral contour more strongly curved than dorsal contour; [7,9,10] anus a little nearer first anal spine than pelvic base; caudal peduncle slender; [10] snout blunt, somewhat shorter than eye; mouth strongly oblique, slightly superior; maxillary broad, emarginate behind, ending under anterior margin of eye; supramaxillary present.[9,10] Scales small; anterodorsal area scaled to a vertical between eye and preopercular margin; area between eye and preopercle and upper part of opercle scaled; most of cheek and opercle and remainder of head scaleless; caudal and pectoral scaled near bases, dorsal and anal lobes moderately scaled, fins otherwise scaleless.[10] Lateral line scutes not larger than adjacent unmodified scales,[7] the spinous points and keel weakly developed; lateral line with a prominent arch anteriorly about 1.5 in straight part; accessory lateral line reaching to dorsal origin.[10] Gill rakers long and slender, about two-thirds length of eye.[9] Adipose eyelid rather well developed posteriorly, moderately developed anteriorly. Spinous dorsal moderate in height, anterior spines rather flexible, connected by membrane, the last spine partly or wholly disconnected; fourth dorsal spine the longest; caudal longer than head; pectoral long and falcate, reaching well beyond soft anal origin; pelvic extending less than half distance from its base to soft anal origin.[10]

Pigmentation: Body dark dorsally above a horizontal line through upper margin of eye, silvery to golden below, the contrast usually abrupt and striking; a black spot at base of caudal, on upper half, partly on peduncle and partly on fin; posterior margin of opercle usually with a black spot, often faint; [10] fins mostly yellowish, median fins with dusky margin.[9]

Maximum size: Largest recorded 305 mm from Brazil,[11] but reported to grow much larger.[7]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts and Bermuda to Uruguay,[7,8] and throughout the Gulf of Mexico; [8] uncommon north of South Carolina.[9] F. H. Berry recognizes 2 geminate species, *C. cosmopolita* in the eastern Atlantic, and *C. orqueta* in the eastern Pacific.

Area distribution: Cape Charles City, Virginia, extremely rare in Chesapeake Bay; [9] Cape May County, New Jersey.[16]

Habitat and movements: Adults—common in schools around pilings; [7] occur offshore to at least the 1800 m curve in the northern Gulf of Mexico and to the 900 m

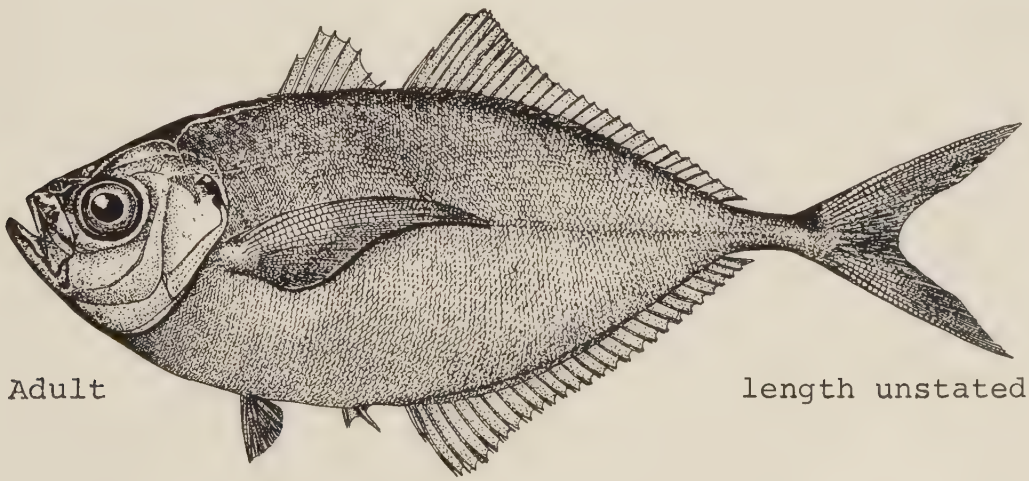

Fig. 25. *Chloroscombrus chrysurus*, Atlantic bumper. A. Adult, length unstated. (*A, Evermann, B. W., and M. C. Marsh, 1902: fig. 36.*)

curve in northeast Florida,[3] but most commonly found within the 18 m [11] line and throughout most of range is rarely taken beyond the 90 m line.[3] Casual in summer and fall off New York and southern New England; [12] present in bays in the Gulf only in summer and fall.[14] Taken in salinities from 12.8–41.1 ppt,[2] but preferring higher salinities [18] and temperatures from 13 [11]–34 C.[2]

Larvae—no information. Germinate species, *C. cosmopolita,* taken off west Africa June–December.[1]

Juveniles—individuals above 25 mm abundant along sandy beaches, smaller specimens frequently taken offshore; [7] frequently commensally associated with jellyfish to at least 39 mm, particularly *Stomoloplus meleagris.*[6] Taken in May, July, August and October in the South Atlantic Bight,[15] mainly during September in the Tampa Bay area,[5] and irregularly off Long Island in September and October.[4] Taken in salinities from 9.3 [13]–34.2 [5] ppt and temperatures from 20.8 [13]–33 C.[5]

SPAWNING

Ripe females reported in June and running ripe males and females taken together in August in Texas (salinity 30.2–36.7 ppt, temperature 27–29 C [14]); absence of young off Texas in late July and August may imply two spawning peaks.[7]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information. The description of Aboussouan, 1968,[1] is based on the geminate species *C. cosmopolita* (FHB).

JUVENILES

No information. The description of Aboussouan, 1968,[1] is based on *C. cosmopolita.* (FHB.)

GROWTH

No information.

AGE AND SIZE AT MATURITY

Males mature at least by 137 mm, females at least by 155 mm.[14]

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Decapterus macarellus (Cuvier), Mackerel scad

DULTS

. VIII–I, 31–37 (modally 33) (including terminal, single-ayed finlet); A. II–I, 27–30 (modally 29) (including erminal, single-rayed finlet); C. 9+8, procurrent rays -9+8 [1]–10; [3] P. 22–24 (modally 23); V. I, 5; total lateral ne scales and scutes 119–133 (excluding 6–13 peduncu-r scales), 19–33 scales in anterior part and 23–32 scutes posterior part of straight lateral line; [1] vertebrae 10+ 4; [1,3] gill rakers 9–13+32–39; branchiostegals 7; small eeth present in jaws, on tongue and palatines, and terally on head and medially on shaft of vomer.[1]

ody proportions as percent SL (145–256 mm): Head 5.2–26.8, depth 16.1–18.9, pectoral fin 15.3–17.5, pelvic n 9.9–12.1, snout 8.3-9.4, eye 5.9–6.9, upper jaw 7.8–8.5.[1]

ody elongate and little compressed; mouth small, max-lary not reaching front of eye; [4] premaxillaries pro-actile.[5] Fins and scalation similar to *D. punctatus.* nterior curved part of lateral line relatively long and w, .79–1.05 in straight part; [1] scutes small, height of rgest about one-third or less of eye diameter.[4]

igmentation: Color in life blue green on back, silvery n sides, a black spot posteriorly on edge of opercle at evel of upper part of eye; [4] pectoral axil black; [5] no dark ots on lateral line; caudal fin reddish.[4]

Differs from *D. punctatus* in having a relatively long, w curved lateral line without spots and a greater total umber of lateral line scales and scutes, and in having greater number of pectoral rays, one additional vertebra nd a more slender body.[1]

Maximum size: Largest recorded 295 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: In the western Atlantic from Nova Scotia and Bermuda to northern Brazil (discontinuously); in the eastern Atlantic at the Cape Verde, St. Helena, and Ascension Islands and in Gulf of Guinea.[1] (Some authors consider the Atlantic form to be conspecific with a similar form in the Indo-Pacific.)

Area distribution: Not recorded from the area but probably occurs here occasionally, as it has been taken both to the north and south.

Habitat and movements: Adults—primarily a pelagic, offshore species, probably associated more with oceanic islands than continental areas; [1] occasionally seen in schools over outer reefs; [4] sometimes abundant in fall at Woods Hole.[2]

Larvae—no information.

Juveniles—no information.

SPAWNING

No information.

EGGS

No information.

YOLK-SAC LARVAE

No information.

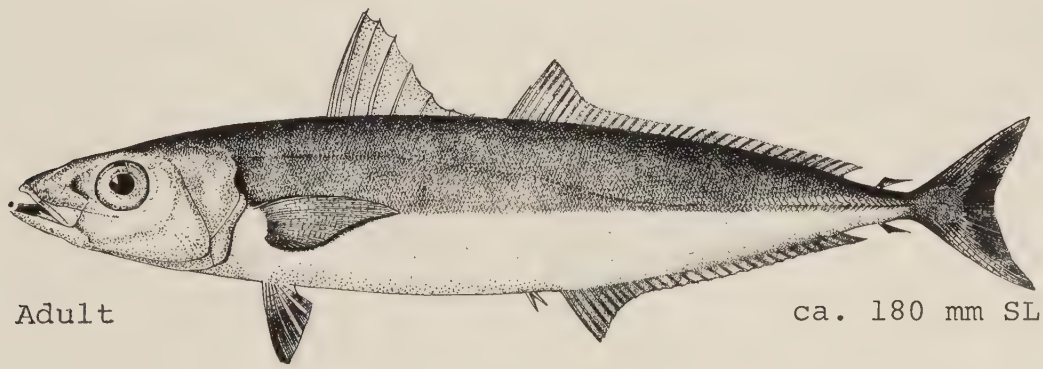

Fig. 26. *Decapterus macarellus,* Mackerel scad. A. Adult, ca. 180 mm SL. (*Goode, G. B., 1884: pl. 102.*)

LARVAE

No information.

JUVENILES

No information.

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Decapterus punctatus (Agassiz), Round scad

ADULTS

D. VIII–I, 29–34 (modally 32) (including the terminal, single-rayed finlet); A. II–I, 25–30 (modally 27) (including the terminal, single-rayed finlet [2]); C. 9+8, procurrent rays 8–9+8–9; [2,8] P. 19–21 [1,2,3] (usually 20 [1,3]); V. I, 5; total lateral line scales and scutes (excluding the 2–6 peduncular scales) 77–98, 1–5 scutes in posterior part of curved lateral line, scutes in straight lateral line 32–46; [2] vertebrae 10+15; [2,8] gill rakers 11–16+32–44; branchiostegals 7; [2] teeth small, in one row in both jaws, sparse in upper jaw, confined to anterior part; [3] teeth present laterally on head and medially on shaft of vomer; [2] teeth present on palatines and in a rather broad band on tongue.[3]

Body proportions expressed as percent SL (140–183 mm): head 25.5–27.5, depth 18.8–23.0, pectoral 18.2–23.5, pelvic 11.0–13.0, snout 7.3–9.1, eye 7.1–7.9, upper jaw 8.3–8.6.[2]

Body slender, spindle shaped; caudal peduncle slender; anus near first anal spine; snout moderate, subequal to eye; mouth small, terminal, strongly inclined to a vertical; maxillary comparatively rather wide, ending under anterior margin of eye; supramaxillary present. First dorsal fin rather high, anterior spines flexible, the third the longest; first dorsal and anal soft rays the longest; pectoral fin extending a moderate distance beyond pelvic fin; pelvic fin reaching half distance from its base to origin of soft anal or a little less.[3] Scales cycloid; body covered with scales except for small areas in pectoral axil and beneath pelvic fins; scales extend anteriorly on top of head to above anterior part of eye, largely covering interorbital area, and ventrally over most of opercle, subopercle and interopercle, extending onto cheek from preopercle to end of maxillary; spinous dorsal and anal scaleless; membranes between first 3 or 4 rays of soft dorsal and anal fins with rows of scales; rows of scales present along anterior margins of pectoral and pelvic soft rays and on membranes between rays of caudal fin.[2] Anterior curved part of lateral line rather low, gradually continuous with straight part; [3] curved portion .92–1.16 in straight portion; [2] entire straight part formed of large scutes,[11] the height of the largest about three-fourths eye diameter; [10] accessory lateral line relatively short, ending near posterior end of supraoccipital crest.[2] Vertical edge of pectoral girdle with a papilla-like projection at its upper and lower extremities.[1]

Pigmentation: Color in life blue green on back, silvery on sides, with a narrow yellow stripe on side of body at level of upper part of eye; a black spot posteriorly on opercle,[1,3,10] just in front of yellow stripe; [10] 10–14 dark spots along curved lateral line.[2] Preserved specimens dark brownish above, silvery with a golden tinge below; spots on lateral line and opercle still evident; a series of faint, dusky transverse streaks anteriorly on lower part of body.[3]

Maximum length: Largest recorded about 205 mm; [11] reported to reach 300 mm.[9,10]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts (FHB) and Bermuda to Rio de Janeiro, Brazil,[2] including the Gulf of Mexico.[3]

Area distribution: Atlantic City, New Jersey; lower Delaware Bay.[6]

Habitat and movements: Adults—a pelagic schooling fish; [10] sometimes taken at surface and close inshore but more frequently taken in bottom trawls in depths from 9–90 m.[2] In the Gulf of Mexico as follows: winter—mostly from 36–90 m; spring—concentrated inside 18 m contour; summer—concentrated between 20–36 m; fall—some movement inshore close to beach, but more or less uniformly distributed from shore line to about 180 m.[12]

Larvae—taken May through November in inshore and offshore waters in the Gulf of Mexico and off the south Atlantic coast of the United States.[4]

Juveniles—smaller juveniles pelagic and apparently prefer oceanic rather than neritic water, but may occur inshore around oceanic islands; taken as far as 432 km offshore; [2] taken both at surface and on bottom to at least 25 mm; [5] remain pelagic to about 80 mm, although may be taken in bottom trawls as small as 45 mm; most large juveniles trawled in depths of 9–90 m; [2] apparently rise to surface during predawn period, occupy surface during day and descend at night.[7] Taken May–November in inshore and offshore waters in the Gulf of Mexico and off the south Atlantic coast of the United States; [4] irregularly common in summer and fall off New York and Massachusetts; [9] migrate southward or offshore during winter.[5]

SPAWNING

Location: Occurs in pelagic inshore and offshore waters and along edge of continental shelf; [4,5] in the Gulf of Mexico, activity appears more concentrated in eastern area.[4]

Season: Apparently occurs year-round with a spring peak; [7] off Beaufort, N.C., 2–4 mm specimens taken May–November, most abundant July–September.[5]

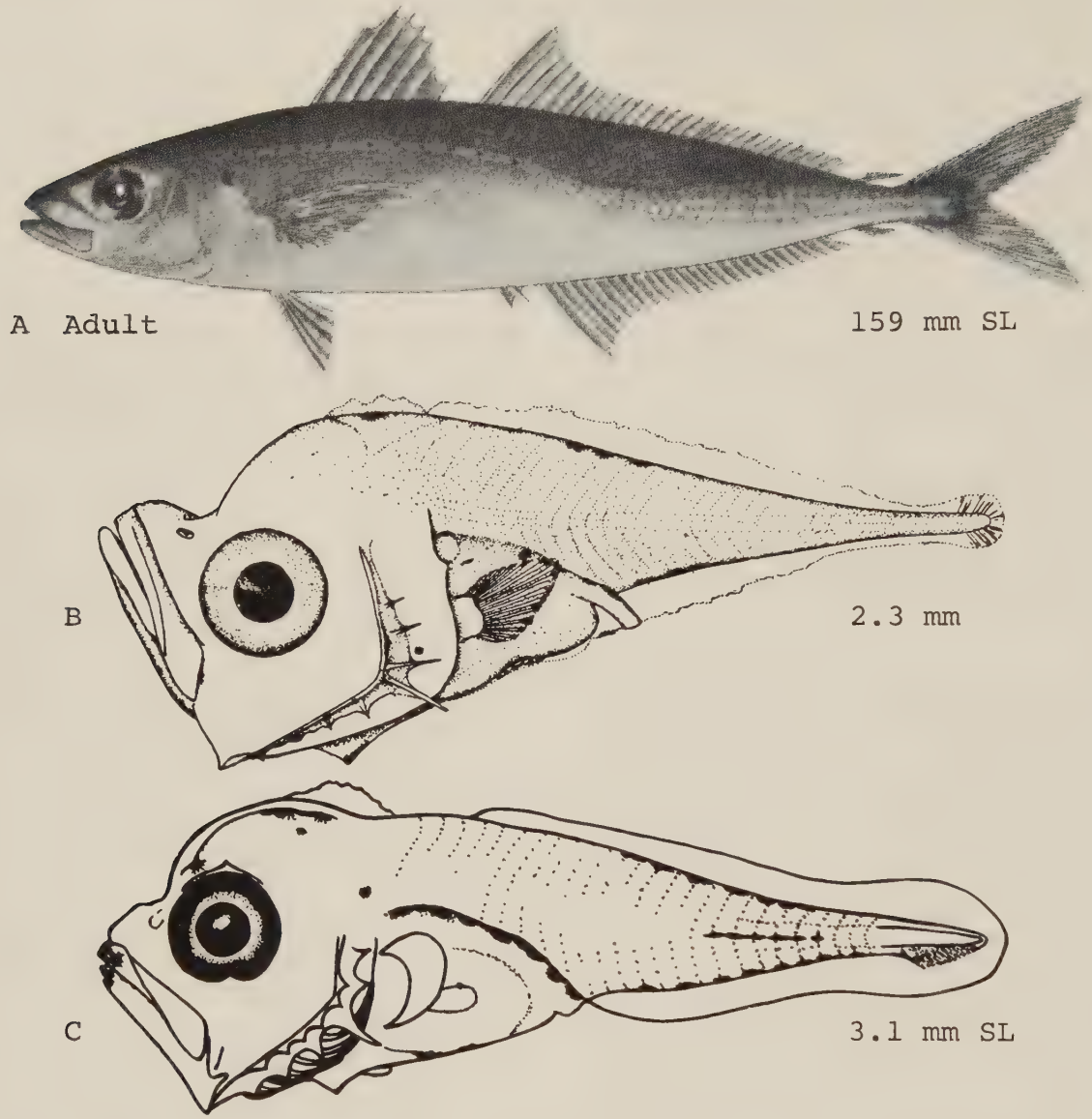

Fig. 27. *Decapterus punctatus,* Round scad. A. Adult, 159 mm SL. B. Larva, 2.3 mm. C. Larva, 3.1 mm SL. (*A, Berry, F. H., 1968: fig. 2. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 68. C, Aprieto, V. L., 1973: fig. 4A.*)

EGGS

No information.

YOLK-SAC LARVAE

No information.

LARVAE

Less than 2 mm to about 13 mm.

At 4–5 mm fin rays begin to ossify in following sequence: caudal; dorsal, anal and pectorals; pelvics. At 10 mm full complement of dorsal rays present,[4] spinous dorsal separated from soft dorsal by a notch,[5] ultimate dorsal and anal fin rays beginning to separate to form finlets. At 9 mm full complement of anal rays present. At 4 mm caudal fin structures initially appear; full complement of principal rays present by 6 mm; notochord flexion occurs between 4–7.8 mm. Pectoral fin bud present at 2.3 mm; fin rays differentiated at 5 mm; full complement present at 11 mm. Pelvic fin bud present at 4–5 mm; fin rays begin to ossify at 6 mm; full complement present by 7 mm,[4] but fin still very small.[5] At 3–7 mm a low orbital crest bearing a weak spine present above eye. Pre-

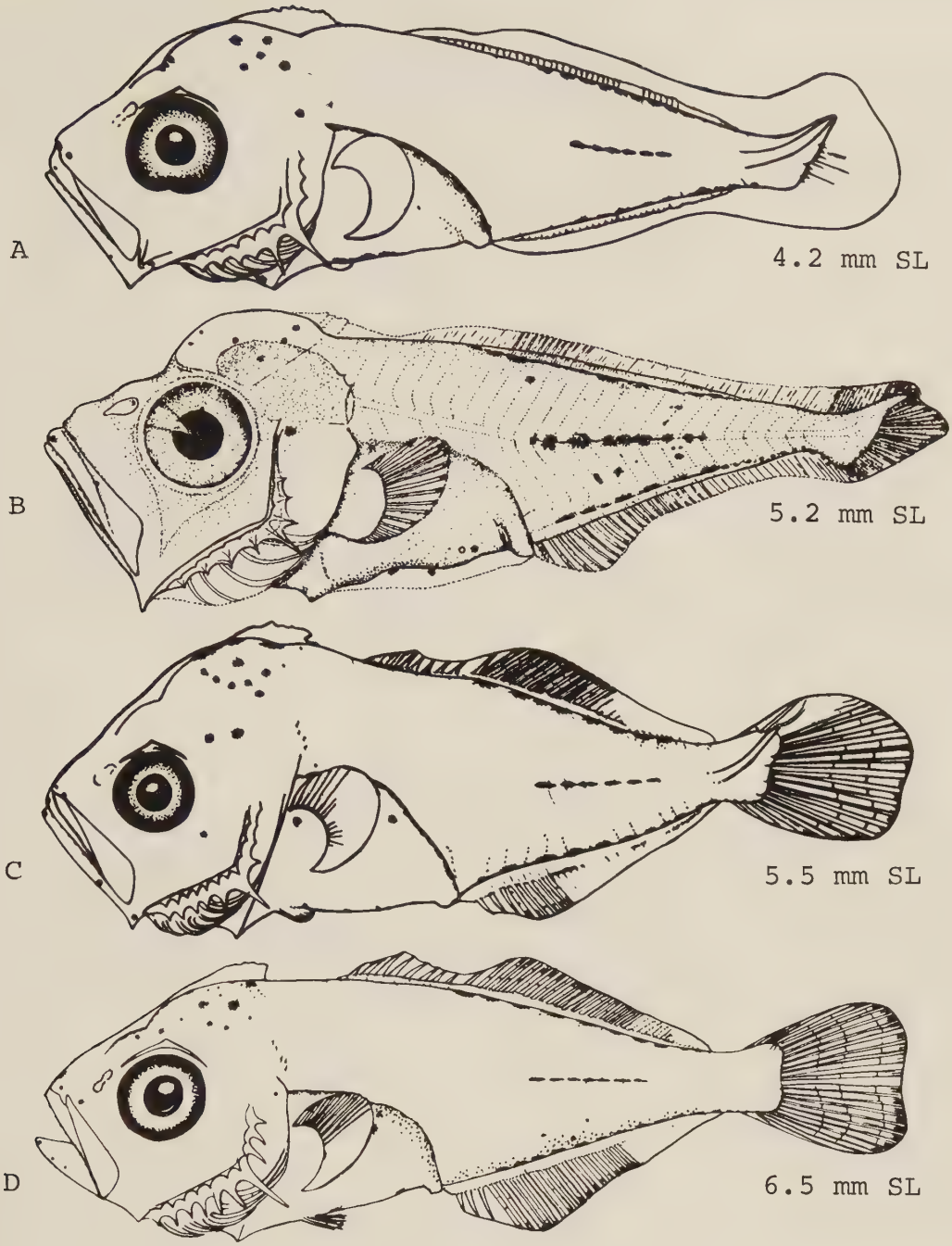

Fig. 28. *Decapterus punctatus,* Round scad. A. Larva, 4.2 mm SL. B. Larva, 5.2 mm. C. Larva, 5.5 mm SL. D. Larva, 6.5 mm SL. (*A, C, D, Aprieto, V. L., 1973: figs. 4B, C, D. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 69.*)

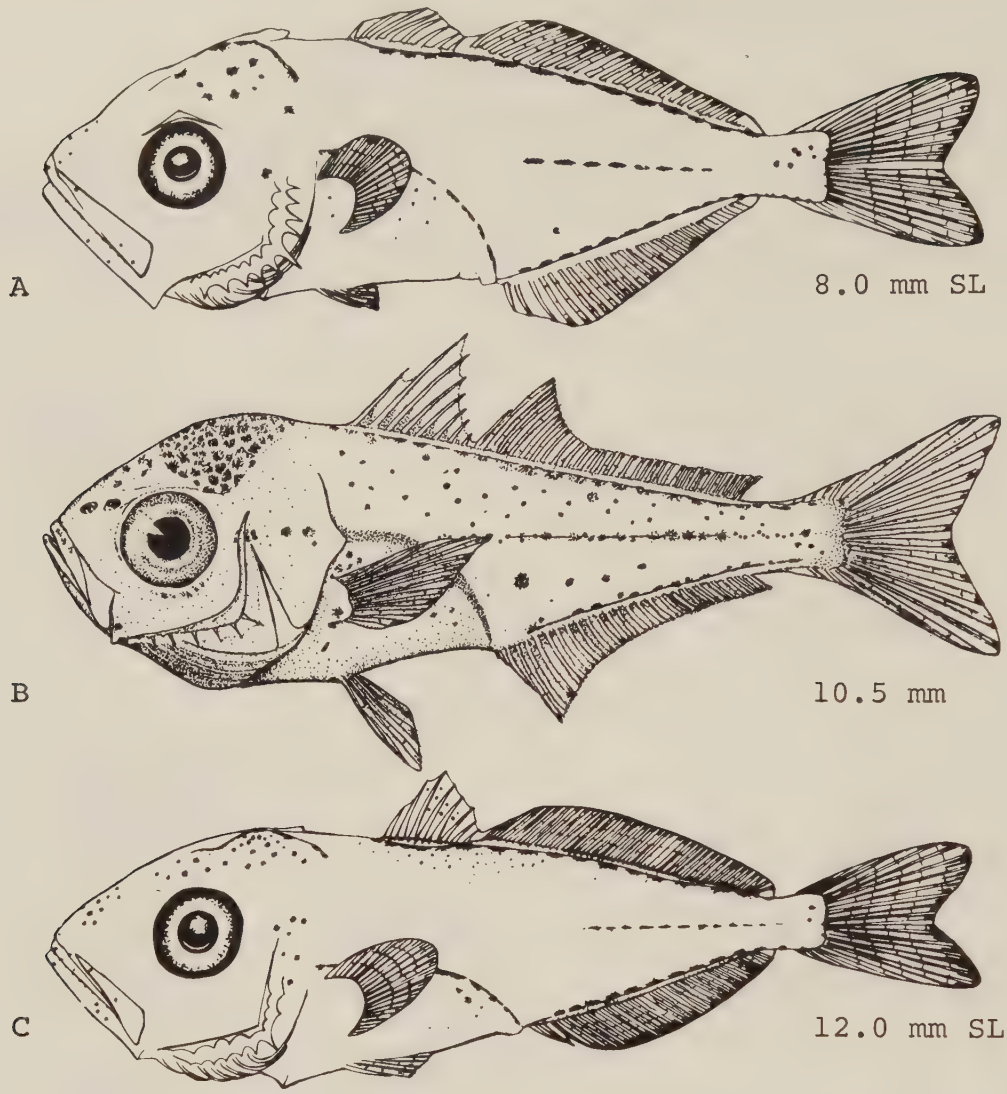

Fig. 29. *Decapterus punctatus*, Round scad. A. Larva, 8.0 mm SL. B. Larva, 10.5 mm. C. 12.0 mm SL. (*A, C, Aprieto, V. L., 1973: figs. 4E, F. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 70.*)

opercle with marginal and lateral spines, increasing in size during larval period. Gut slender, coiled in a single loop in early larvae; at 2.3 mm anus somewhat behind mid-body; at 5 mm hypaxial muscles begin to develop around gut; at 7 mm abdominal cavity completely enclosed except at anus.[4]

Depth 30.6–35.4% SL, head 27–35% SL, eye 30–46.1% SL, snout to anus 52.3–59.5% SL. Snout slightly concave at 3 mm, straight by 4 mm, eventually convex.[4]

Pigmentation: Chromatophores slow to develop in larvae and remain sparse until early juvenile stages.[4] At 2.3 mm a few dark markings usually evident along dorsal and ventral outlines of body at base of finfold. At 3.5 mm chromatophores more intense, especially on caudal region; a few dark chromatophores present on median lin of side, posterior to anus (a useful diagnostic characte at this size). At 5 mm chromatophores more numerou a few present on head; 3 or 4 longitudinal rows melanophores on side extending backward from a ve tical through anus. At 7 mm chromatophores on hea more numerous. Specimens 7–35 mm retain a concen tration of chromatophores along posterior part of latera line and along base of anal fin; many have a singl row of chromatophores between these rows.[13] At 10 m a concentration of dark chromatophores on head pr ducing a black blotch on occipital surface; a well de fined black line on midline of caudal region (a usefu recognition character).[5]

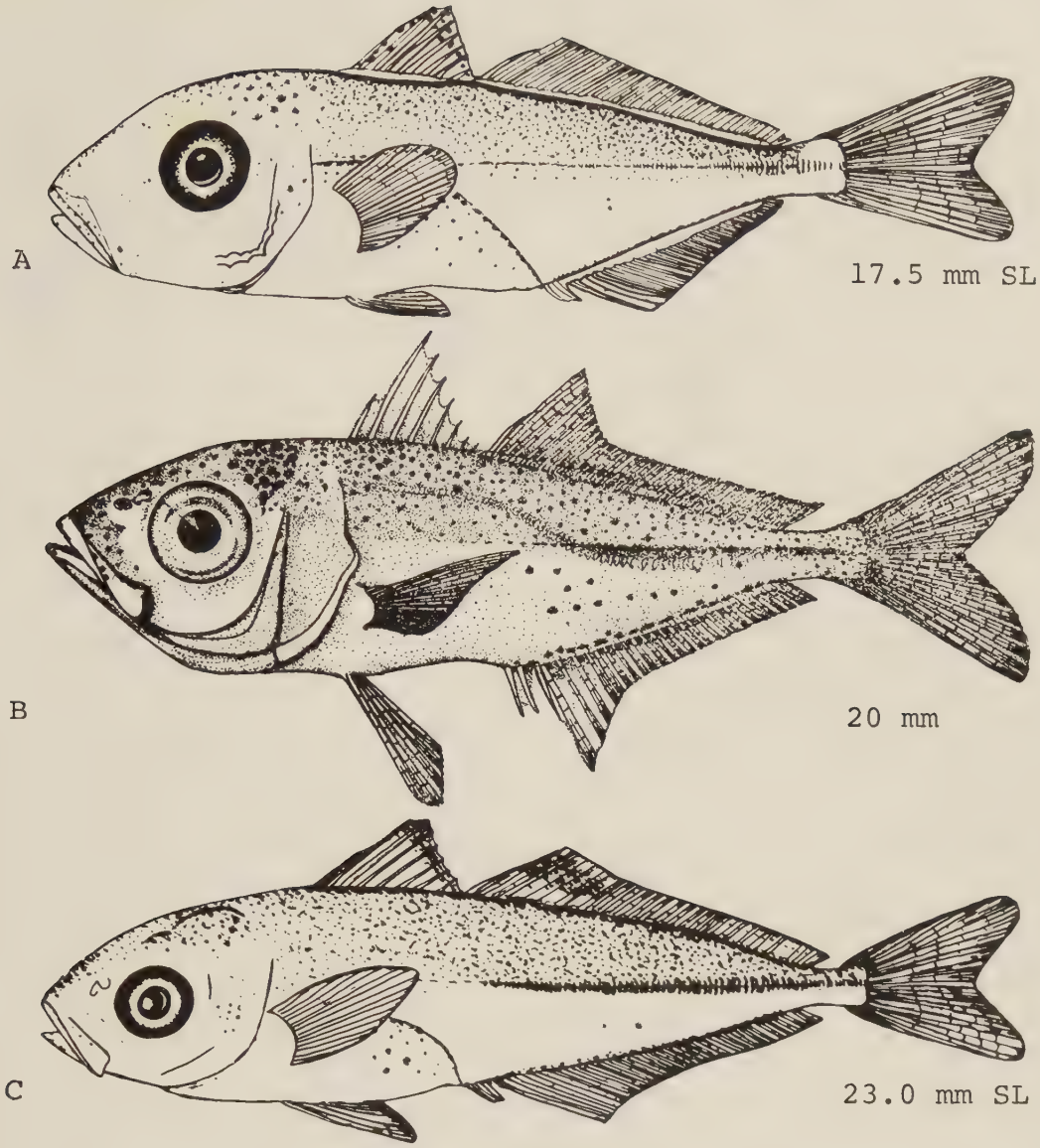

Fig. 30. *Decapterus punctatus,* Round scad. A. Juvenile, 17.5 mm SL. B. Juvenile, 20 mm. C. Juvenile, 23.0 mm SL. (*A, C, Aprieto, V. L., 1973: figs. 4G, H. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 71.*)

JUVENILES

About 13 mm and larger.

Full complement of procurrent caudal rays formed by 13 mm; caudal deeply forked at 15 mm.[5] Dorsal and anal finlets close to penultimate soft rays to about 18 mm, then becoming gradually displaced posteriorly; membrane connecting dorsal and anal finlets to penultimate soft rays degenerates at about 40–50 mm; membrane connecting eighth and ninth dorsal spines present to about 30–50 mm; membrane connecting second and third anal spines present to about 30–40 mm.[2] At 45 mm pelvics reach about two-thirds distance from their base to anal origin.[5] At 10 mm orbital crest completely resorbed. At 17 mm lateral surface spines of preopercle absent and marginal spines reduced to fine crenulations on preopercular margin; at 20 mm preopercular margin smooth. At 17 mm scales in posterior region of lateral line ossify; ossification of lateral line scales proceeds anteriorly and full complement of scales and scutes present by 20 mm when body scales form. Gut with 3 loops by early juvenile stage.[4] At 15 mm depth of head equals depth of body, both about 3 in SL. At 30 mm body notably elongate but remains strongly compressed, depth about 3.6 in SL; snout rather pointed; mouth oblique and terminal; maxillary reaching to or slightly past anterior margin of eye. At 45 mm, depth 3.8 in SL.[5]

Pigmentation: In early juveniles, iridiophores spread all

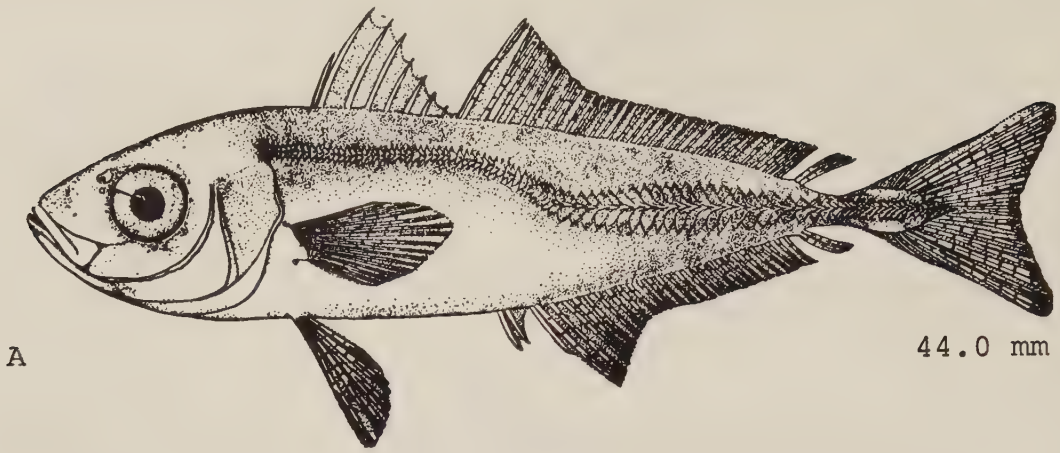

Fig. 31. *Decapterus punctatus,* Round scad. A. Juvenile, 44.0 mm. (*A, Hildebrand, S. F., and L. E. Cable, 1930: fig. 72.*)

over body but are most dense below lateral line, producing a metallic sheen.[4] At 15 mm preserved specimens have a brownish cast along back, a dark blotch over head, and a dark lateral stripe. At 30 mm mostly silvery, back slightly brownish, dark lateral stripe absent.[5] Curved lateral line spots begin to form on some as early as 70 mm, and the usual complement of 12–14 may be present as early as 81 mm.[2]

GROWTH

Probably reach 50 mm within 4–5 months.[5]

AGE AND SIZE AT MATURITY

No information.

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Elagatis bipinnulata (Quoy and Gaimard), Rainbow runner

ADULTS

D. VI (rarely V)–I, 25–30 (modally 27) (including terminal two-rayed finlet); A. I–I, 18–22 (modally 19) (including terminal two-rayed finlet); C. 9+8,[1,8] procurrent rays 7–11+10–11; [8] P. 19–22; V. I, 5; lateral line scales ca. 100 to 106 (FHB); vertebrae 10+14; [1,8] 8 pleural ribs, 13–14 epipleural ribs; gill rakers 9–12+25–29; [1] branchiostegals 7; [1,7] a band of small recurved canine teeth on each side of upper and lower jaws, the bands broader near symphysis, remaining teeth minute; an elongate median patch and scattered irregular patches of very small teeth covering most of dorsal surface of tongue; vomerine tooth patch rounded anteriorly and laterally, with an acutely shortened posterior shaft; a band of small teeth on palatines and irregular patches covering much of remainder of palate.[1]

Head 3.5–4.0, depth 4.0–4.8 (FHB), pectoral fin 6.6–7.7 in SL; snout 2.7–3.4, eye 3.7–5.0, maxillary 2.9–3.0 in head.[9]

Body spindle shaped, slender,[3] with a rather sharp, pointed head profile; [4] snout rather long, moderately tapering; mouth small, terminal; maxillary ending at a considerable distance in front of eye, moderately broadening posteriorly; supramaxillary present, relatively narrow; anus near normal position of first anal spines; caudal peduncle rather deep for a carangid. Spinous dorsal rather low, the 6 spines connected by a membrane, the anterior spines rather flexible; [3] first anal spine relatively short and covered by skin in large specimens; [1] dorsal and anal lobes rather low; fold at base of fins moderate anteriorly, absent posteriorly; a detached finlet about 2 fin ray spaces behind dorsal and anal fins,[3] composed of last 2 closely-spaced rays of each fin; [4] caudal fin longer than head; pectorals short, ending in front of end of pelvics; pelvics short, extending less than half distance from base to soft anal origin.[3] Scales ctenoid, covering body and extending onto median part of caudal fin, dorsal fleshy part of opercle, and cheek behind and beneath eye to end of upper jaw; low scaly sheath present along anterior bases of dorsal and anal fins; scales present along bases of pectoral and pelvic fins; small scales extending between rays of caudal fin to near end of fin; most of head scaleless.[1] Lateral line with a very low anterior curve, continued imperceptibly into posterior straight part; scales in lateral line not scute-like; accessory lateral line extending posteriorly for only a short distance, falling short of a point opposite preopercular margin, forming boundary of scaled part on dorsal aspect.[3]

Pigmentation: In life back greenish blue; a broad, dark blue stripe high on side, followed in succession down by a narrow, light blue stripe, a broader cadmium yellow stripe, and frequently another light blue stripe; remaining third of sides and belly white or yellowish silver; fins greenish yellow.[4]

Maximum length: Largest recorded about 1195 mm.[5]

DISTRIBUTION AND ECOLOGY

Range: Circumtropical,[2] occasionally extending into temperate waters; [7] widespread, but nowhere abundant; in the western Atlantic from Massachusetts to northeastern Brazil,[1] including the Gulf of Mexico [5] and West Indies; [1] in the eastern Pacific from Cape San Lucas, Baja California to northern Peru and the Galapagos and Cocos islands.[4]

Area distribution: No actual records, but occurrence north and south of the area indicates it probably occurs here at least as an occasional stray (GDJ).

Habitat and movements: Adults—usually found near surface in oceanic waters, sometimes far offshore.[1]

Larvae—pelagic, often associated with *Sargassum;* taken in Gulf of Mexico and southeastern coast of United States in every month except May and December.[2] Most abundant epipelagic carangid larva in tropical and subtropical Indo-West Pacific, where it is most numerous in March in waters of about 28 C.[7]

Juveniles—frequently found in pelagic *Sargassum* community; [1,2] taken in Gulf of Mexico and southeastern coast of United States in every month except May and December; [2] in Indo-West Pacific most abundant at about 28 C.[7]

SPAWNING

Occurs offshore throughout the year; [2,7] in the Indo-West Pacific appears to occur in waters warmer than 27 C, with a peak in March.[7]

EGGS

No information.

YOLK-SAC LARVAE

No information.

LARVAE

Less than 3.8 mm to about 12 mm.

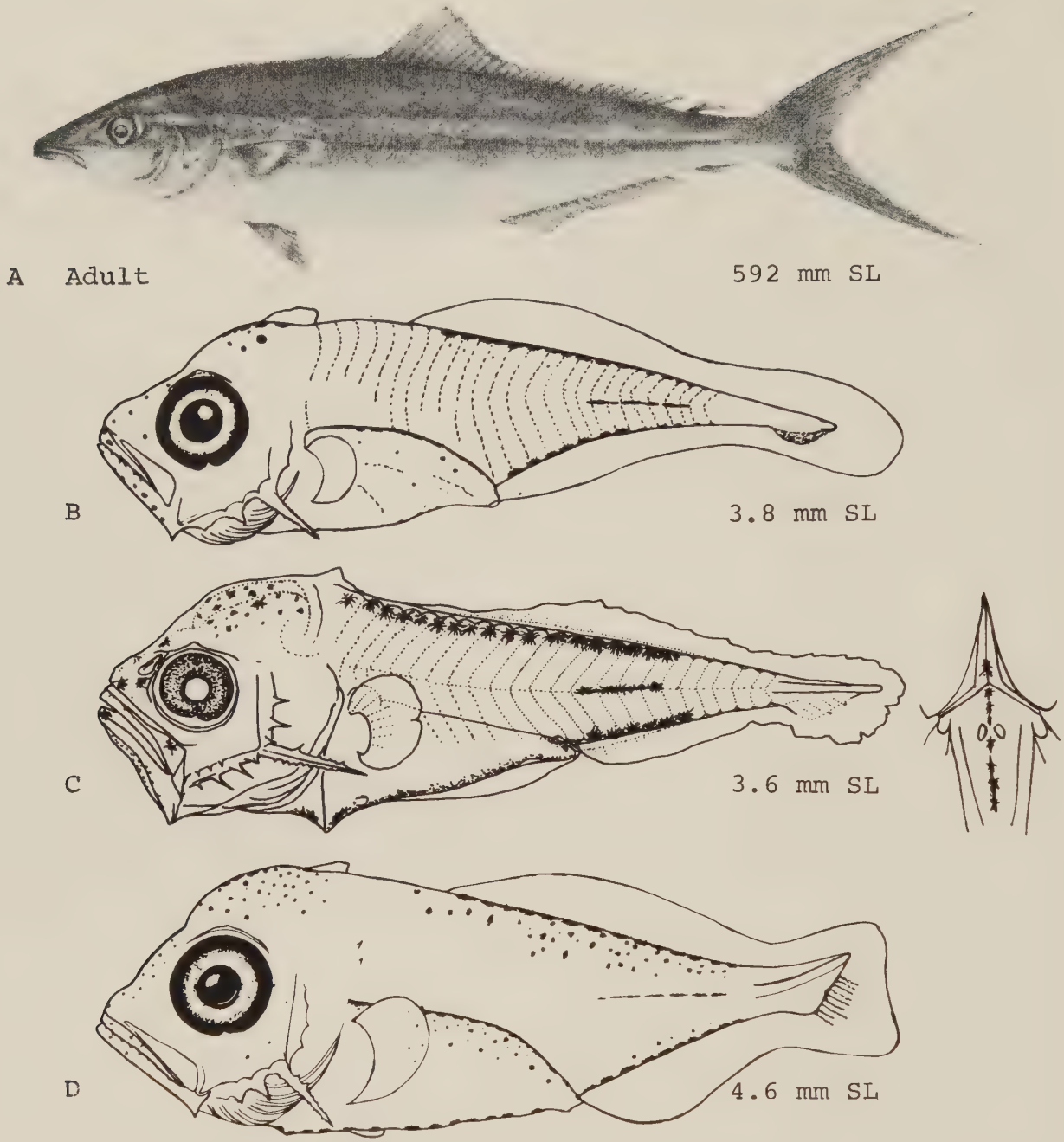

Fig. 32. *Elagatis bipinnulata,* Rainbow runner. A. Adult, 592 mm SL. B. Larva, 3.8 mm SL. C. Larva, 3.6 mm SL. D. Larva, 4.6 mm SL. (*A, Berry, F. H., 1969: fig. 1. B, D, Aprieto, V. L., 1974: figs. 1A, B. C, Okiyama, M., 1970: fig. 1.*)

Rudiments of all fins except pelvics present by 3.8 mm. Anteriormost dorsal rays ossified by 5 mm; [2] at 5.5 mm 14 dorsal rays present; [7] at 10 mm full complement present. Anteriormost anal rays ossified by 5 mm; [2] at 5.5 mm 7 anal rays present; [7] at 10 mm full complement present. At 3.8 mm a thickening near tip of notochord evident; at 4.5 mm hypurals evident, notochord beginning to flex, and median caudal rays ossified; [2] at 5.5 mm 15 caudal rays present; [7] at 6 mm procurrent rays beginning t ossify, and hypurals completely ossified; at 7 mm fu complement of principal rays present; at 8 mm not chord flexion complete. Dorsalmost pectoral rays oss fied at 5 mm; full complement present by 8 mm. Pelvi rays begin to ossify at 6 mm; full complement presen by 8 mm. At 3.8 mm 10+14 myomeres (full compl ment) present.[2] At 3.6 mm preopercle with 8 spines i

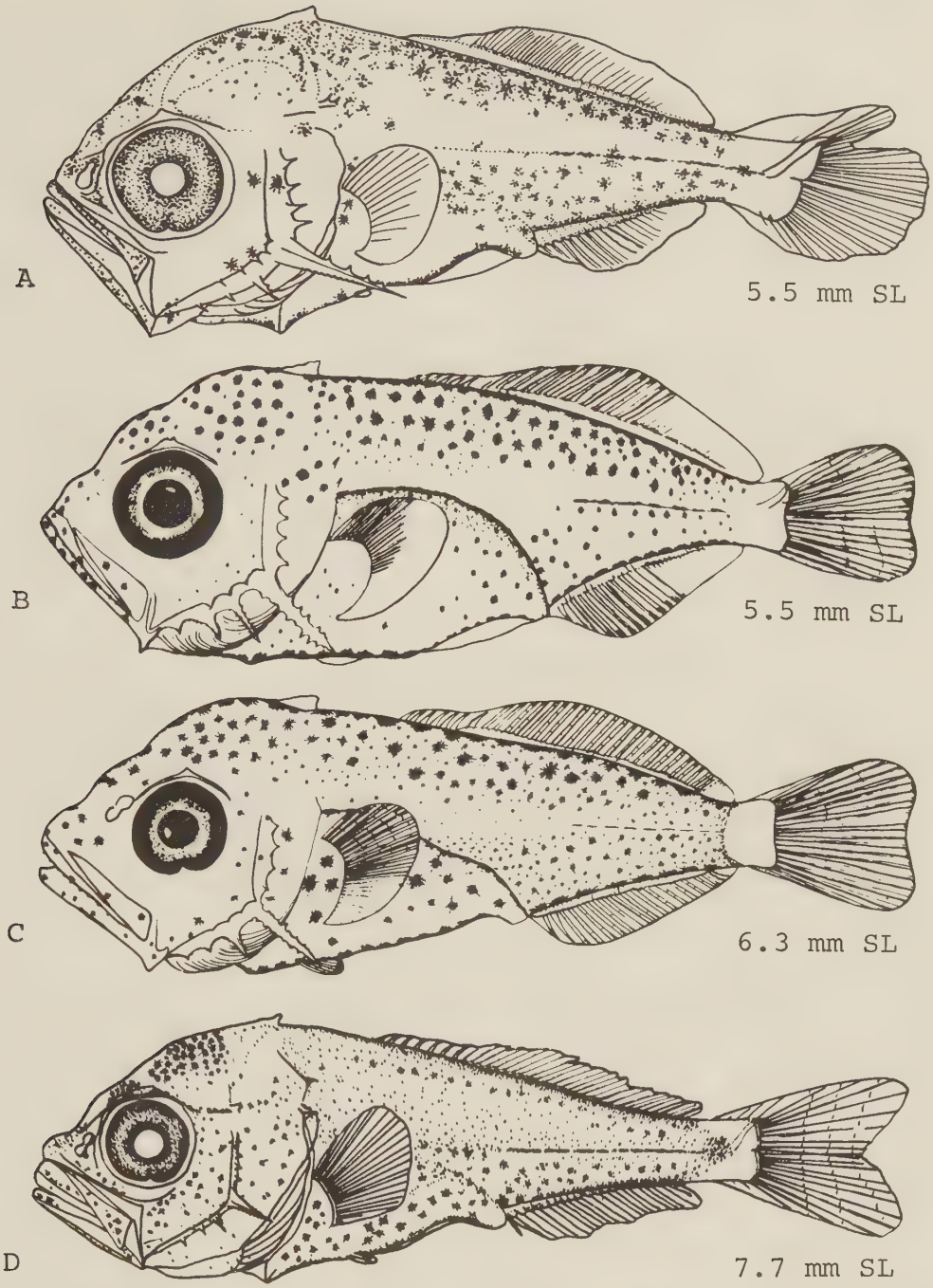

Fig. 33. *Elagatis bipinnulata,* Rainbow runner. A. Larva, 5.5 mm SL. B. Larva, 5.5 mm SL. C. Larva, 6.3 mm SL. D. Larva, 7.7 mm SL. (*A, D, Okiyama, M., 1970: figs. 2, 3. B, C, Aprieto, V. L., 1974: figs. 1 C, D.*)

nner and 3 in outer series, the spine at the angle about ne-half length of head, strongly serrated ventrally and omewhat dorsally; at 5.5 mm spine at angle stouter and xtends beyond pelvic base; at 7.7 mm preopercular pines reduced, the spine at angle not reaching beyond percular margin. At 5.5 mm 2 temporal spines present; t 7.7 mm 2 additional spines appear at uppermost orner of gill cleft and just behind eye.[7] A supra-occipital crest present throughout larval stage. At 5 mm gut enclosed by hypaxial muscles; at 8 mm hypaxial muscles completely cover abdominal cavity except anus.[2] Gill rakers 4+11 at 5.5 mm.[7]

Pigmentation: Larva intensely pigmented. At 3.6 mm a group of well spaced small chromatophores around symphysis of pectoral girdle (a useful character for identification at this stage).[7] At 3.8–4.6 mm most conspicuous

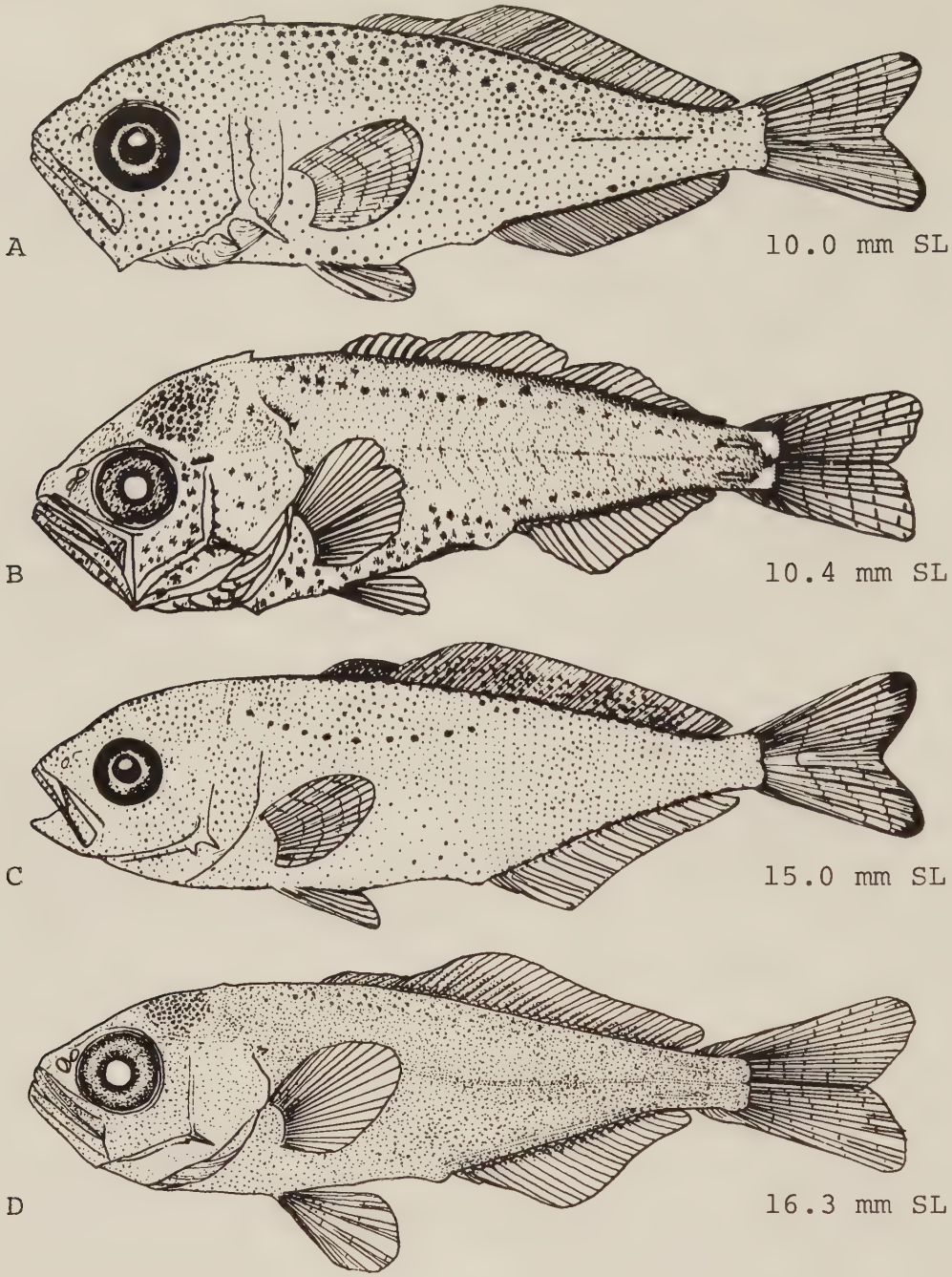

Fig. 34. *Elagatis bipinnulata,* Rainbow runner. A. Larva, 10.0 mm SL. B. Larva, 10.4 mm SL. C. Juvenile, 15.0 mm SL. D. Juvenile, 16.3 mm SL. (*A, C, Aprieto, V. L., 1974: figs. 1E, F. B, D, Okiyama, M., 1970: figs. 4, 5.*)

pigment includes melanophores along bases of dorsal and anal fins and along lateral midline; small patches of melanophores on head, jaws, snout, and on upper sides of body; internal pigment concentrated on upper sides of body. At 5–6 mm melanophores developed profusely all over body leaving only a small unpigmented area at caudal peduncle; a row of closely spaced pigment cells along mid-ventral line below gut (useful in distinguishing from *Seriola*).[2] At 7.7 mm pigment particularly wel developed over brain and mid-lateral portion of cauda peduncle; a marked increase in chromatophores ove opercular region; fins still unpigmented. At 10.4 mm denser distribution of chromatophores on body parallel ing each myotome; large chromatophores linearly alon bases of dorsal and anal fins and sparsely on body particularly distinctive is a pair of short, linear, un

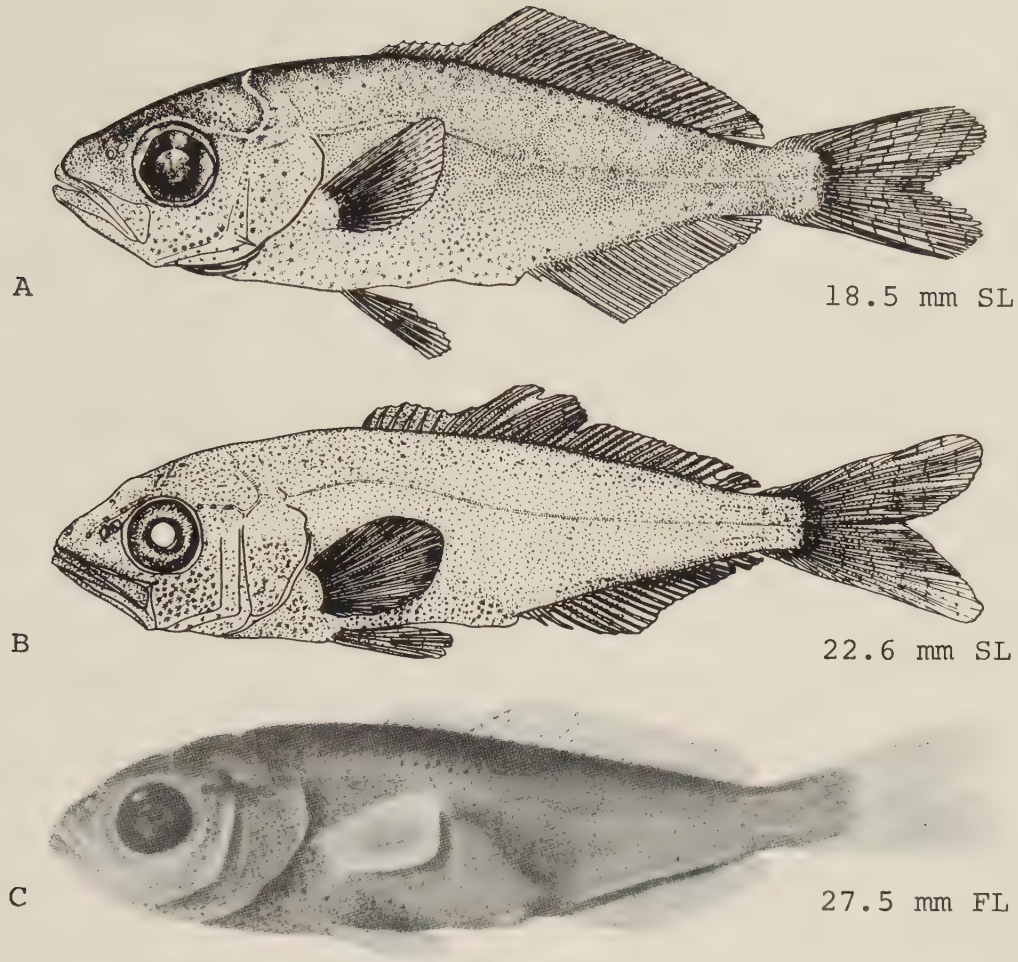

Fig. 35. *Elagatis bipinnulata,* Rainbow runner. A. Juvenile, 18.5 mm SL. B. Juvenile, 22.6 mm SL. C. Juvenile, 27.5 mm FL. (*A, Berry, F. H., 1969: fig. 2. B, Okiyama, M., 1970: fig. 6. C, Fahay, M. P., 1975: fig. 14.*)

pigmented areas on sides of caudal peduncle.[7] Xanthophores develop profusely on head and back in late larvae.[2]

UVENILES

About 12 mm and larger.

Full complement of procurrent rays present by 12 mm.[2] At 18.5 mm 2 terminal dorsal soft rays only slightly displaced from antepenultimate soft ray and connected to by a membrane; at 33 mm pterygiophores well formed and medial radials of the 2 terminal pterygiophores well formed and of similar length; by 7.2 mm medial radial of penultimate pterygiophore disproportionately elongated to move the 2 terminal rays caudad; elongation continues with growth to further displace finlet; at about 85 mm membrane connecting antepenultimate and penultimate soft rays begins to degenerate and by as small as 150 mm, the finlet may be isolated; a deeply incised but intact membrane may persist to 235 mm. Development of anal finlet is essentially identical. In large specimens, the membranous connections between spines of first dorsal are lost and distal margins of posterior 12–15 soft rays are excised and superficially resemble finlets.[1] By 16.3 mm most of head armature absent, but temporal spines and spine at preopercular angle still evident; by 22.6 mm no trace of head spines. By 16.3 mm lateral line well developed. Between 14.5–16.0 mm a loop appears in gut; at 22.6 mm body slender, snout pointed; by 76.0 mm body shape much like adult (depth about 3.7 in SL).[7]

Pigmentation: In early juveniles, iridiophores, xanthophores and melanophores cover whole length of body except on jaws and fins (not evident in preserved specimens); an irregular row of large melanophores present on upper side of body.[2] At 16.3 mm an increase in pigment on all areas except caudal fin; first dorsal entirely pigmented and second dorsal pigmented about half way out rays; small amount of pigment at base of anal, pectoral and pelvic fins; in addition to the pair of un-

pigmented lines on caudal peduncle, a similar line present along base of anal fin [7] (these are key features for identification [6]). At 22.6 mm caudal fin with numerous small chromatophores. At 76 mm 3 dark lateral stripes appear.[7]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Oligoplites saurus (Bloch and Schneider), Leatherjacket

ADULTS

D. V (sometimes VI)–I, 19–21 (modally 20); A. II–I, 18–21 (modally 20 [4]); C. 9+8, procurrent rays 9–10+6–8 [16] (8–10 [2]); P. 15–17 (modally 16 [4]); V. I, 5; [2] vertebrae 10+16; [2,16] gill rakers 3–7+13–18; branchiostegals 7; [11] teeth in jaws moderately small; [4] premaxillary teeth essentially in 2 distinct rows, an additional row of minute teeth sometimes occurring anteriorly; [11] teeth on vomer in a rather wide posteriorly tapering band; tongue nearly covered with granular teeth.[4]

Head 4.7–4.9, depth 3.4 [10]–3.9 in SL; [7] snout 3.2 [8]–3.7,[10] eye 3.6 [8]–4.3, maxillary 1.7 [10]–1.9,[8] pectoral fin 1.5–1.6 in head.[10]

Body elongate, spindle shaped, well compressed, moderately trenchant except lower profile anterior to anal fin; anus near first anal spine; snout rather pointed; mouth large, oblique, subterminal, lower jaw slightly projecting; maxillary long and thin, ending under posterior margin of eye or a little short; [4] supramaxillary absent; [11] premaxillaries not protrusible,[3,4,11] connected anteriorly to snout at midline by a wide fleshy bridge.[11] First dorsal spines normally detached from one another, short and pungent, increasing moderately in length posteriorly; [4] anterior 2–3 dorsal spines inclined forward; posterior 6–9 [3] dorsal and anal soft rays fanning out distally into a profusion of branches, each ray partly detached (distally) from adjacent ones, presenting appearance of a series of semi-attached finlets; [4] ultimate and penultimate rays more closely spaced than adjoining rays, fully connected by interradial membrane; [11] anterior dorsal and anal rays moderately elevated, the fold at their bases obsolescent, very slightly evident anteriorly; caudal subequal to head; pectoral fin short, reaching a vertical through end of pelvic fins or a little short; pelvic fins reaching to about half distance from base to soft anal origin,[4] depressible into shallow abdominal grooves.[11] Scales acicular, long and very narrow, well embedded with outlines visible at surface; body and antedorsal area scaled to opposite preopercular margin; head and fins scaleless.[4] Lateral line making a fairly marked upward angle at a moderate distance from beginning, descending moderately from that point to merge imperceptibly with straight part; scutes absent; accessory lateral line short, extending only a short distance posteriorly.[4] Anterior rim of pectoral girdle smooth, without fleshy papillae or deep groove near isthmus.[11]

Pigmentation: In life greenish silver on back, silvery (sometimes golden) on sides and ventrally; caudal fin bright yellow.[7] Preserved specimens dusky or with a metallic bluish sheen on body and head above a horizontal line through upper angle of opercle; lower parts silvery or golden; some specimens silvery nearly all over; fins yellowish.[4]

Readily distinguished by long, narrow, needle-shaped or spicule-like embedded scales with visible outlines, lack of lateral line scutes, non-protractile upper jaw, and semi-detached, finlet-like posterior dorsal and anal soft rays.[4]

Maximum size: Reaches at least 285 mm FL, but seldom exceeds 250 mm.[11]

DISTRIBUTION AND ECOLOGY

Range: In the western Atlantic from Gulf of Maine [17] to Montevideo [3] and throughout the Gulf of Mexico,[4] and most of the Caribbean; in the eastern Pacific in the Gulf of California at least to Concepcion Bay, along the outer coast of Baja California to Magdalena Bay, and south to Esmeraldas, Ecuador, and the Galapagos Islands.[11]

Area distribution: Chesapeake Bay at Lynnhaven Roads, Virginia; [10] Atlantic and Monmouth counties, New Jersey.[9]

Habitat and movements: Adults—found along sandy beaches and in inlets and bays, where they seem to prefer tidal currents; [3] schooling fish, more often occurring in turbid than clear water; [7] tolerate water of low salinity.[3,7] Taken in shallow waters from spring or summer through late fall.[13,14] Taken in salinities from 0–45.2 ppt and temperatures from 16.1–34.5 C.[1]

Larvae—no information.

Juveniles—appear on west coast of Florida during June and July.[4] Apparently pass through stage (particularly between 26–40 mm) during which they clean ectoparasites from other fishes; [6] at about same size, an apparent leaf mimicry behavior has been observed, in which they rest near the surface head-down or twisted so as to resemble a half water-logged leaf; [5] larger juveniles common on periphery of shallow, protected grass beds in Puerto Rico (FDM). Taken in salinities from .25 [12]–31.6 ppt [13] and temperatures from 22.8 [12]–34.5 C.[15]

SPAWNING

Occurs in shallow, inshore waters [2] apparently from early spring to midsummer,[10] probably extending over a period of about 4 months.[15]

EGGS

Pelagic, .87–.88 mm in diameter; membrane smooth;

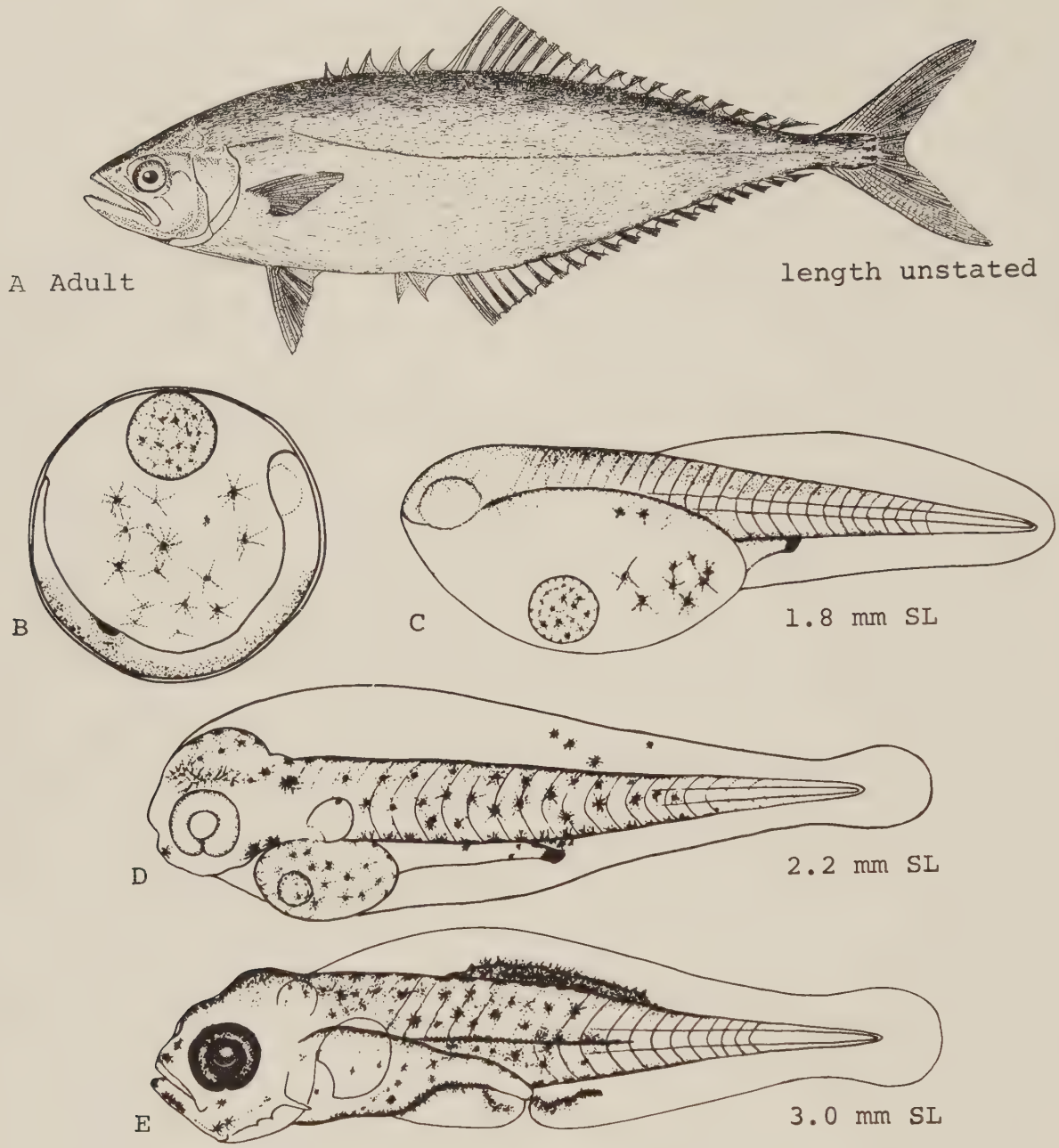

Fig. 36. *Oligoplites saurus*, Leatherjacket. A. Adult, length unstated. B. Egg with developing embryo. C. Yolk-sac larva, 1.8 mm SL. D. Yolk-sac larva, 2.2 mm SL. E. Larva, 3.0 mm SL. (*A, Bigelow, H. B., and W. C. Schroeder, 1953: fig. 206. B-E, Aprieto, V. L., 1974: figs. 8A-D.*)

perivitelline space narrow; yolk bright yellow, unsegmented; one oil globule, .33–.34 mm in diameter, ventral. Embryo, when well developed, with stellate melanophores along back and upper sides of body; a large melanophore present at posteroventral midline.[2]

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

1.87–1.97 mm at hatching.

Body slender, head well marked, eye buds discernible; gut straight. During first day, yolk sac reduced to spherule; eyes formed but unpigmented; dorsal and anal finfolds completely surround fish, except at mouth.[2]

Pigmentation: Melanophores present along sides and

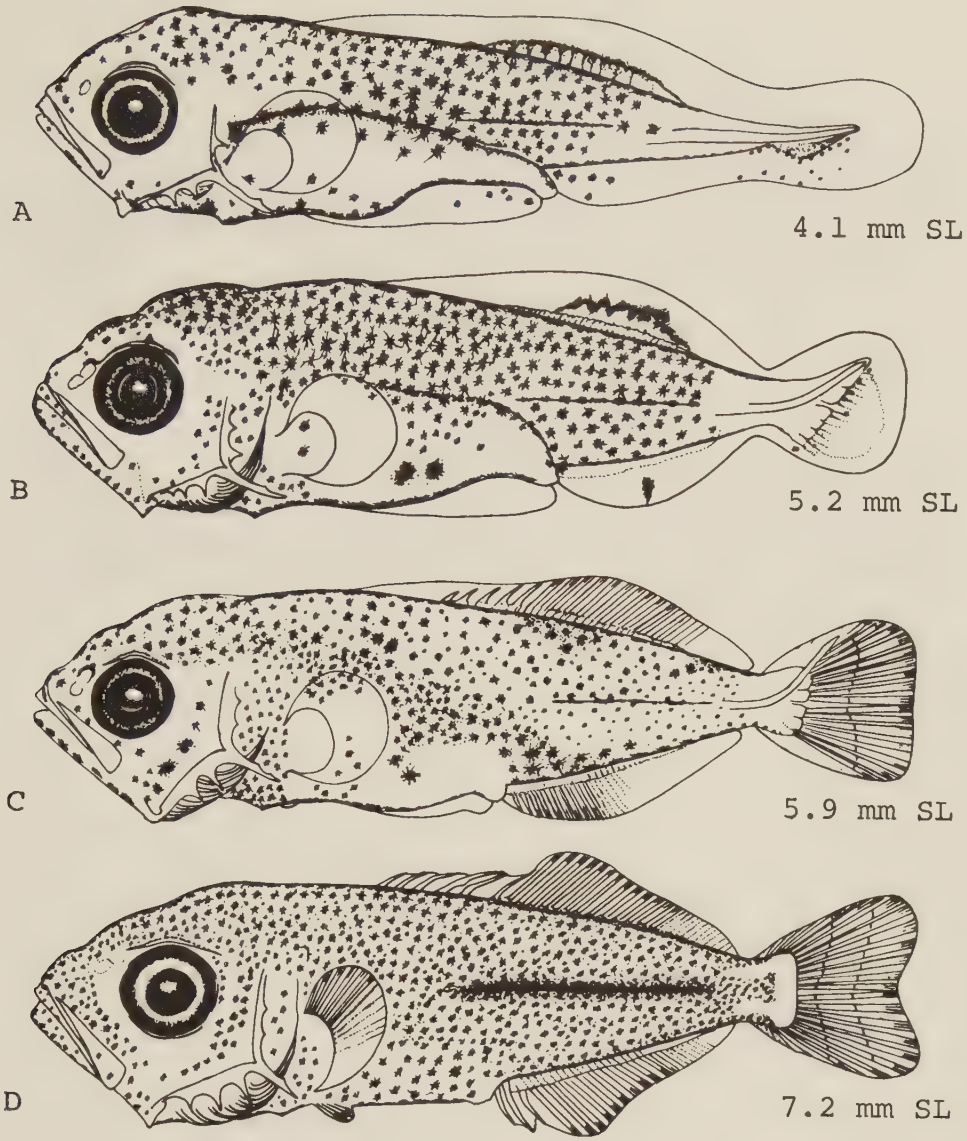

Fig. 37. *Oligoplites saurus,* Leatherjacket. A. Larva, 4.1 mm SL. B. Larva, 5.2 mm SL. C. Larva, 5.9 mm SL. D. Larva, 7.2 mm SL. (*Aprieto, V. L., 1974: figs. 8E-H.*)

back; a large ventral melanophore located at opening of gut.[2]

LARVAE

3 mm to about 10 mm.

Fins ossify in following sequence: (1) dorsal, anal and caudal; (2) pectorals and pelvics. Pectoral finfold present one day after hatching, rays begin to ossify dorsally and are added ventrally. Pelvic buds appear at 6 mm, 13 days after hatching. Dorsal profile of snout initially convex, except for slight indentation at anterior margin of forebrain. At 4 mm a finely serrated orbital crest present. Preopercular spines present, but only marginal ones well developed; 1–3 denticles occur on dorsal side of longest marginal spine. At 4 mm gut forms loop and is completely enclosed by hypaxial muscles; at 7.2 mm abdominal cavity completely covered by hypaxial muscles.[2]

Body depth ranges from 20–26.9% SL during larval stage, increasing to 32% at metamorphosis and then declining to 28–29%; head length ranges from 23–36% SL and head depth from 82–100% HL during larval and juvenile stages; eye diameter ranges from 20–44% SL during larval and early juvenile stages.[2]

Pigmentation: Initially well developed and progressively increases; conspicuous melanophores present along bases of dorsal and anal fins, on lateral midline and on dorsal

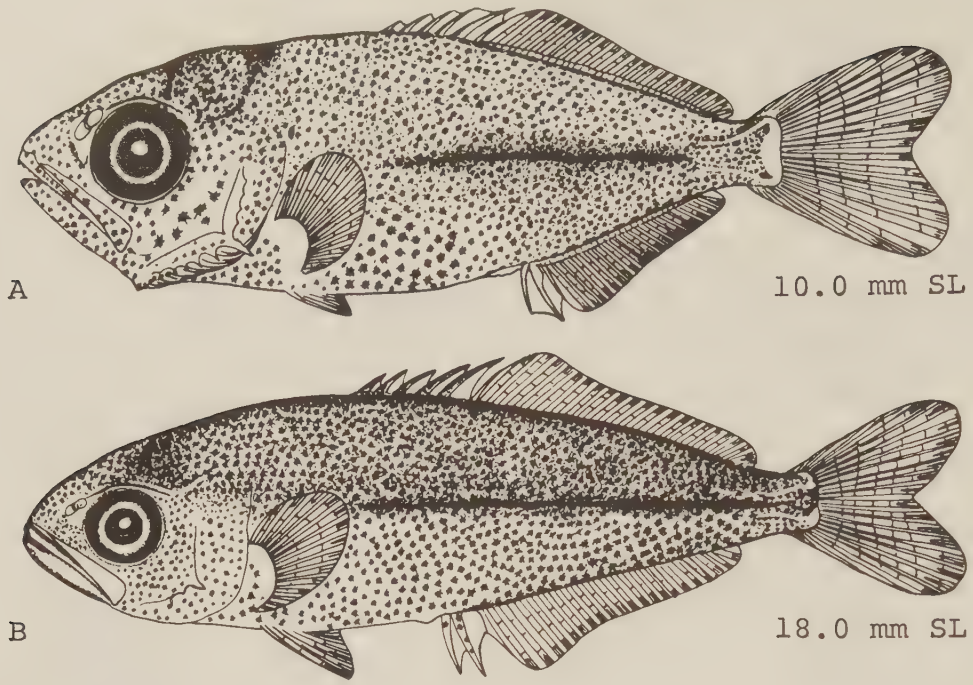

Fig. 38. *Oligoplites saurus,* Leatherjacket. A. Juvenile, 10.0 mm SL. B. Juvenile, 18.0 mm SL. (*Aprieto, V. L., 1974: figs. 8 I-J.*)

wall of abdominal cavity. The conspicuous anal pigment spot present in embryo and early larvae absent by third day after hatching; at 7.2 mm a conspicuous U-shaped unpigmented area on caudal peduncle.[2]

JUVENILES

About 10 mm and larger.

All fins with full complement of fin rays by 10 mm. Orbital crest gradually resorbed during early juvenile stage. Scales and lateral line not yet developed by 25 mm.[2] Outer row of teeth initially closely spaced, flattened, incisiform (possibly associated with purported cleaning behavior).[6]

Pigmentation: Chromatophores present on membranes of dorsal and anal fin spines of early juveniles; U-shaped, unpigmented area on caudal peduncle persists to about 20 mm.[2]

GROWTH

In a rearing experiment, averaged 1.92 mm at hatching; 5.2 mm after 8 days; 21 mm after 34 days; 25 mm after 45 days; most dead after 51 days.[2]

AGE AND SIZE AT MATURITY

No information.

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Selar crumenophthalmus (Bloch), Bigeye scad

ADULTS

D. VIII–I,[3,6,7,18] 23[7,18]–26[3,6,7,8,18] (usually 25[6]); A. II–I,[3,6,7,18] 20[8,19]–23[3,6,7,18] (modally 22[6]); C. 9+8, procurrent rays 7–8+7–8;[8] P. 19[4]–22[6,7] (modally 21[6]); V. I, 5;[13] total lateral line scales 84[6,7]–94;[7] 50–58 scales in anterior part of lateral line;[6] 30[3,6,7]–44[8] pointed scutes in straight lateral line; vertebrae 10+14;[1,10] gill rakers 9–12[3]+27–30;[3,6,7] branchiostegals 7; teeth small, in one row in lower jaw, 2 rows in upper jaw; teeth in a narrow band on palatines and head of vomer, none on shaft of vomer; a rather wide to medium band of teeth on tongue.[6]

Head 3.0[18]–3.3,[13,18] depth 3.1[18]–3.8[17,18] in SL; snout 2.9[17]–3.9, eye 2.7[18]–3.3,[13] maxillary 2.1[18]–2.5, pectoral 1.2, pelvic 2.1[17] in head.

Body moderately slender, rather spindle shaped; caudal peduncle moderately slender; anus placed at a moderate distance from first anal spine; snout moderate, obtuse, subequal to notably large eye; adipose eyelid very well developed, covering greater part of eye; mouth medium, well inclined, subsuperior, lower jaw projecting; maxillary of moderate width, ending under anterior margin of pupil; supramaxillary present. First dorsal fin rather high, the spines connected by membranes, the anterior spines rather flexible; the 2 disconnected anal spines well developed; dorsal and anal fin lobes moderately elevated, the fold at their bases moderate; caudal fin shorter than head; pectoral fin moderately long, about reaching origin of soft anal in large specimens; pelvic fin moderately long, reaching more than half distance from its base to soft anal origin. Scales small; antedorsal area and interorbital scaled nearly to opposite anterior margin of eye; cheek, opercle and interopercle largely scaled; fins more or less scaled. Anterior curve in lateral line very low, continued very gradually into posterior straight part;[6] no scutes in curved lateral line;[3] height of scutes in straight part about half eye diameter;[7] accessory lateral line ending under beginning or middle of first dorsal. Pectoral girdle with 2 papillae on vertical limb,[3,6] a furrow or groove below the lower.[3]

Pigmentation: Color in life gray green on upper third of body, silvery with iridescence on lower two-thirds, the two regions separated by a brassy yellow band one-half pupil or less in width; tips of caudal lobes dusky; sometimes a little dark pigmentation along upper edge of gill cover, but no definite spots as on *Decapterus* and *Trachurus*.[7]

Differs from *Decapterus* in the absence of terminal finlets; differs from *Trachurus* in having 2 well developed papillae on pectoral girdle, and in not having anterior scales in lateral line expanded transversely.[6]

Maximum size: Largest recorded 270 mm;[6,9] reported to reach over 600 mm in tropical waters.[3]

DISTRIBUTION AND ECOLOGY

Range: Worldwide in tropical and subtropical waters; in the western Atlantic from Nova Scotia and Bermuda to Rio de Janeiro, Brazil, including the West Indies[3] and the Gulf of Mexico;[12] in the eastern Pacific from Cape San Lucas and Muertos Bay, Baja California to Cabo Blanco, Peru and at the Galapagos Islands.[3]

Area distribution: Lower Chesapeake Bay at Cape Charles City[10] and Lynnhaven Roads, Virginia;[13] upper Chesapeake Bay, Calvert County, Maryland;[11] Atlantic, Cape May, Monmouth counties, New Jersey.[14]

Habitat and movements: Adults—occur in small aggregations or large schools, often very near shore; may occur over shallow reefs, but usually where water is turbid.[7] Common in fall in Massachusetts and New York.[16] Taken in salinities from 27–37.4 ppt and temperatures from 15.1–26.5 C.[15]

Larvae—taken in the Java Sea from May–June[5] and in the Gulf of Guinea from November–January in salinities from 34.6–35.7 ppt and temperatures from 24–26 C.[2]

Juveniles—no information.

SPAWNING

Probably occurs far offshore; males and females in breeding condition taken in June from Tortugas, Florida.[9]

EGGS

Pelagic;[1] average diameter .77 mm; yolk segmented[1,5] (not evident in preserved specimens), the segments larger toward center of yolk;[1] a single oil globule, .24 mm in diameter,[1,5] yellow, located at anterior end of yolk sac. Black and brown pigment spots present on embryo, oil globule, and yolk, especially on dorsal side.[1]

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

Hatch at 1.3 mm.

Myomeres 7+17; oil globule .15 mm in diameter. At 1.95 mm, 20 hours after hatching, much of yolk absorbed, oil globule .10 mm. At 2.4 mm, 44 hours after hatching

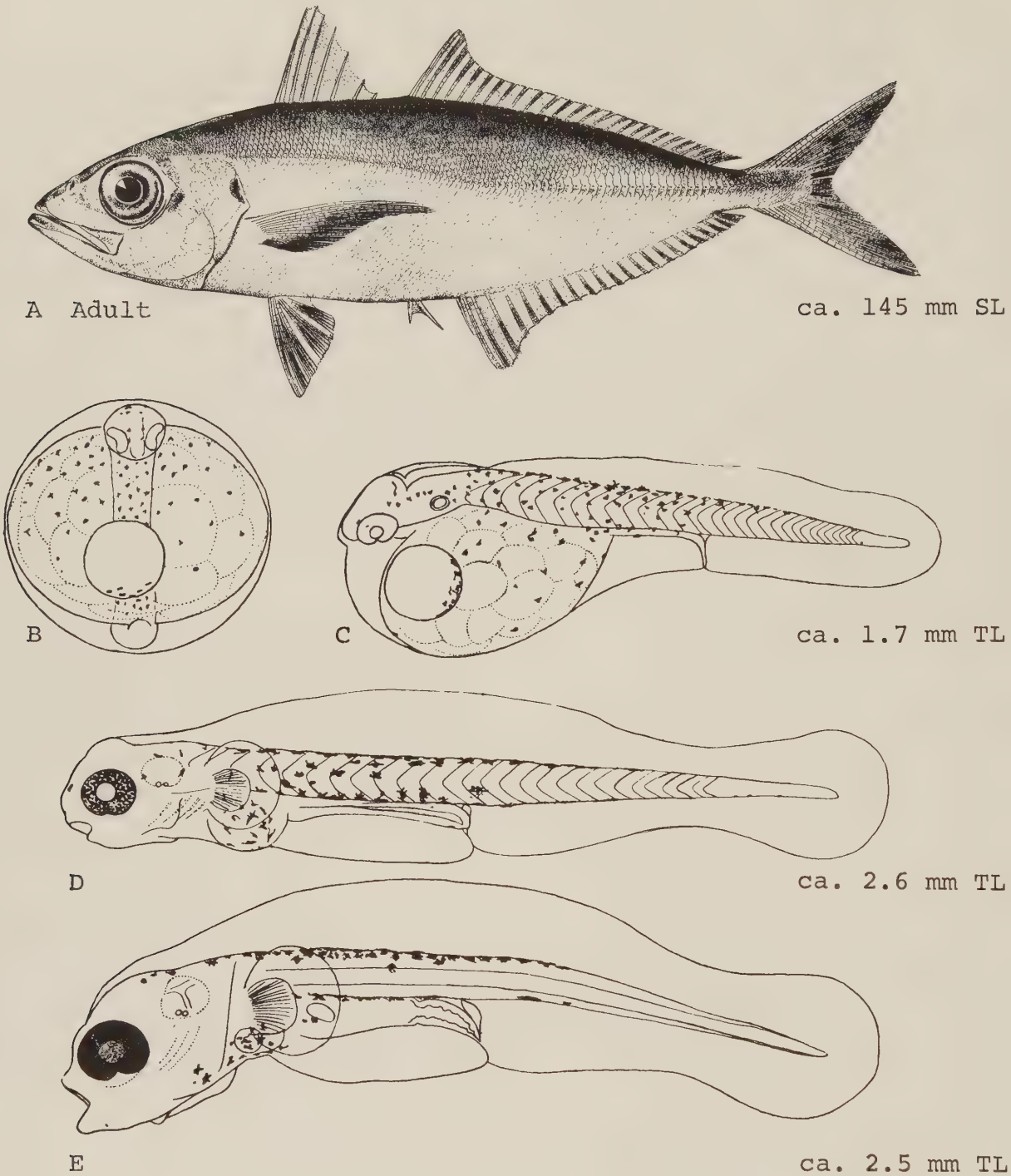

Fig. 39. *Selar crumenophthalmus*, Bigeye scad. A. Adult, ca. 145 mm SL. B. Egg. C. Yolk-sac larva, ca. 1.7 mm TL. D. Yolk-sac larva, ca. 2.6 mm TL. E. Yolk-sac larva, ca. 2.5 mm TL. (*A, Goode, G. B., 1884: pl. 100. B-E, Delsman, H. C., 1926: figs. 9–12.*)

Fig. 40. *Selar crumenophthalmus,* Bigeye scad. A. Juvenile, ca. 75 mm SL. (*Fowler, H. W., 1928: fig. 37.*)

myomeres 10+14, indicating a posterior shift in anus. At 64 hours after hatching, yolk completely absorbed.[5]

Pigmentation: At 1.95 mm 3 distinct patches of chromatophores along ventral side of myotomes posterior to anus; head slightly opaque; 2 dark patches of melanophores on anterior portion of head. At 2.4 mm eye almost black with a silvery lid; chromatophores appear along dorsal portion of myotomes in 3 patches.[5]

LARVAE

No information.

JUVENILES

No information.

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Selene setapinnis (Mitchill), Atlantic moonfish

ADULTS

D. VIII–I, 20–23 (modally 22 [1]); A. (II) 0–I,[1] 16 [5]–19 [1,14] (modally 18, nearly as often 17 [1]); C. 9+8, procurrent rays 8–9+7–8; [5] P. 17–19 (modally 18 [1]); V. I, 5; [3] scales in straight part of lateral line 62–81; [1] vertebrae 10+14; [5] gill rakers 5–8+25–29; teeth very small, one row in lower jaw, a narrow band in upper jaw; vomer with a rather extensive patch of teeth continued in a long narrow band on shaft; palatine without teeth; tongue with a broad band of teeth, tapering anteriorly.[1]

Head 2.5 [14]–3.5, depth 1.2 [3]–1.9,[14] pectoral 2.5–3.7 in SL; snout 2.0–2.4, eye 3.5 [3]–4.5,[14] interorbital 3.4–4.6, maxillary 2.2–2.9 in head.[3]

Body very deep, strongly compressed, outline of head and body trenchant; [1] head short and deep; [14] dorsal profile from soft dorsal origin to above eye nearly horizontal, anterior profile from opposite front of eye upward nearly a vertical line, these 2 lines nearly perpendicular to each other; lower profile to anal origin moderately rounded; profile at base of dorsal and anal a nearly straight inclined line to a rather slender caudal peduncle; anus placed near pelvic base; snout long, preorbital broad. Adipose eyelid fairly developed posteriorly, slightly anteriorly. Mouth small, inclined at about 45°, lower jaw projecting; [1] maxillary broad, reaching to or almost to anterior margin of eye; [1,14] supramaxillary present.[1] Scales minute, antedorsal area and head scaleless; upper part of body above a horizontal through straight part of lateral line to within a moderate distance from caudal peduncle, only partly and irregularly scaled, mostly scaleless; lateral line scutes nearly confined to caudal peduncle, not evident in smaller specimens, only moderately developed in larger fish, not larger than adjacent scales, no definite points posteriorly, the keel only moderately indicated. Anterior curve in lateral line high, its chord only a little shorter than straight part; accessory lateral line ending under beginning of first dorsal. Gill rakers usually somewhat longer than half eye. Spinous dorsal divisible into 2 parts, an anterior part of 4 rather flexible spines connected by a weak membrane, and a posterior part of 4 short, stout pungent spines, widely spaced and disconnected; anterior part of spinous dorsal changes markedly with growth being prolonged and filamentous in early juveniles and disappearing by 240 mm or larger; the posterior 4 dorsal spines becoming relatively shorter with growth, in larger specimens lying flat with their posterior surface closely attached to midback, their sharp points protruding backward; 2 anterior, disconnected anal spines disappearing by about 125 mm, the third broad, short and pungent; dorsal and anal lobes moderate, that of dorsal slightly better developed; a fold at dorsal and anal bases slightly developed for a short distance anteriorly; pectorals long and falcate, reaching some distance beyond posterior bend in lateral line; pelvics very short; caudal shorter than head.[1]

Pigmentation: Preserved specimens golden yellowish or silvery with a metallic bluish tinge above, smaller specimens with a black spot on opercle, disappearing with growth; [1] second dorsal fin plain pale grayish, sometimes light yellow at base; caudal fin greenish yellow; pectoral fins light yellow or dusky greenish; [8] tip of lower jaw black.[14]

Size: Reported to reach over 600 mm,[15] but generally less than 225 mm.[8]

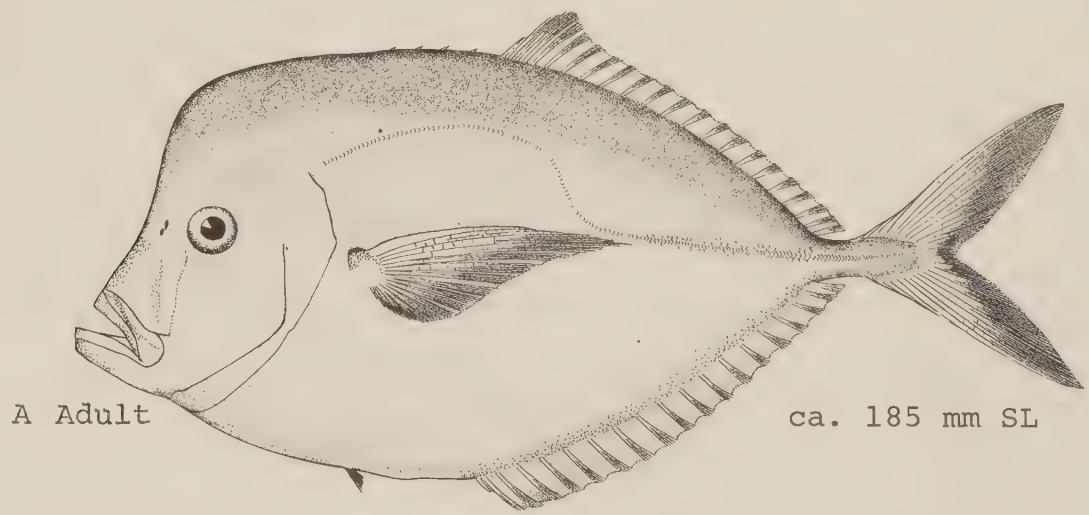

Fig. 41. *Selene setapinnis*, Atlantic moonfish. A. Adult, ca. 185 mm SL. (*Goode, G. B., 1884: pl. 97.*)

Fig. 42. *Selene setapinnis,* Atlantic moonfish. A. Juvenile, ca. 30 mm SL. (*Fowler, H. W., 1936: fig. 317.*)

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic, from Nova Scotia to Uruguay, rare north of Cape Cod;[3] common from Chesapeake Bay southward.[8]

Area distribution: Chesapeake Bay at Lynnhaven Roads and Ocean View, Virginia,[3] and Calvert County, Maryland; [11] Ocean City and Sinnepuxent Bay, Maryland; [13] Atlantic, Monmouth and Ocean counties, New Jersey.[6]

Habitat and movements: Adults—restricted to waters of high salinity; [7,10] in western Gulf of Mexico most common during summer in water of less than 27 m. Taken in Texas every month except January and February, most abundant in August, least abundant in December and March; most abundant in Louisiana in September and October; [10] most abundant in Mississippi in April.[12] Taken in salinities from 17.4 [10]–37.9 [12] ppt (in Texas only 3.2% taken in salinities less than 30 ppt) [10] and temperatures from 13.3 [12]–30 C.[10]

Larvae—no information.

Juveniles—commonly seen swimming and browsing around piers at Ocean City, Maryland in July and August; [9] sometimes common at Woods Hole in August and September; [8] specimens 43–58 mm taken from July to

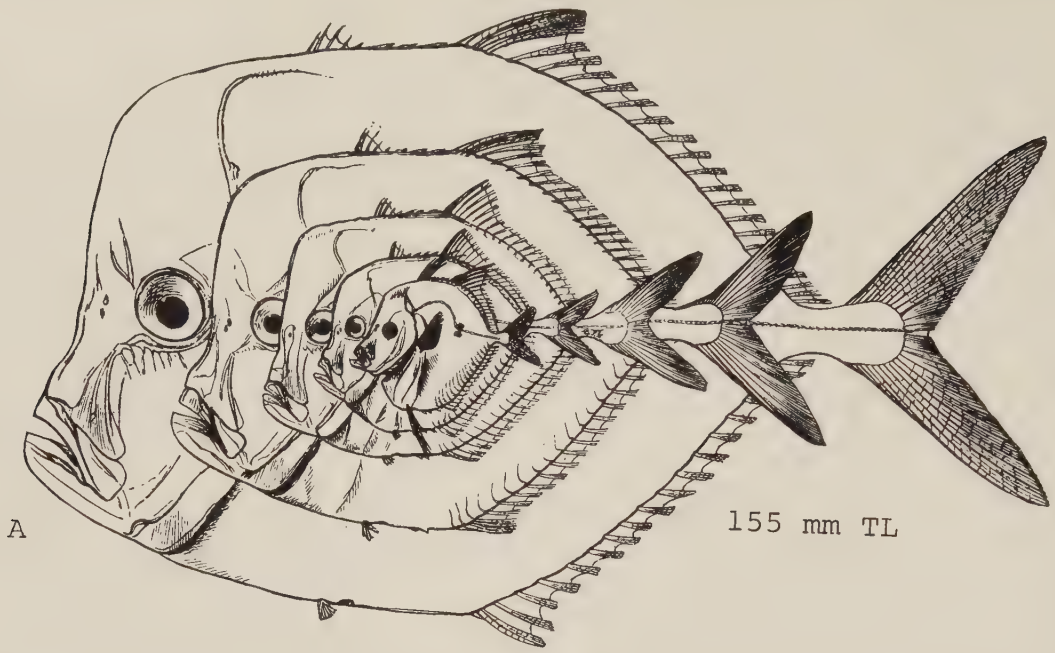

Fig. 43. *Selene setapinnis*, Atlantic moonfish. A. Five juveniles, showing basic changes in body form with growth, from front to back: 35 mm TL, 50 mm TL, 80 mm TL, 100 mm TL, 155 mm TL. (*Lütken, C. F., 1880: 543.*)

October in Texas.[10] A 38 mm specimen taken in St. John's river in July at 14.5 ppt and 29.2 C.[16]

SPAWNING

A female with nearly ripe gonads taken in July in western Gulf; [4] juveniles 43–58 mm taken from July to October in Texas.[10]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Specimens described 35 mm and 60 mm plus some of unstated length.

Early juveniles with the first 4 dorsal spines produced as filaments, the second the longest, reaching more or less beyond beginning of soft dorsal, sometimes to its middle; the filaments lost early, only moderately developed by 60 mm; in medium sized specimens the 4 anterior spines short, slender, flexible, the first about half as long as second, the second to fourth graduated. At 35 mm 2 anterior anal spines present as fixed, projecting points; third spine broad and short and with a procumbent spur.[1]

Pigmentation: A rounded, transversely elongate black spot athwart beginning of straight part of lateral line, becoming faint between 60–80 mm and eventually disappearing; a transversely oblique, narrow dusky band over eye disappearing sooner.[1]

Distinguished from *Selene vomer* by having shorter first dorsal filaments and pelvics and a prominent dark spot on body.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

Probably mature at least by 165 mm.[4]

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Selene vomer (Linnaeus), Lookdown

ADULTS

D. VIII–I,[2,9] 20[2]–23 (modally 22); A. (II) 0–I,[9] 16[2]–20 (modally 19[9]); C. 9+8, procurrent rays 7–9+7–8; P. 18[2]–21; [2,9] V. I, 5; [18] scales in curved lateral line about 72–84, scales in straight part of lateral line 73–75 plus 5–10 on caudal fin (FHB); gill rakers 6[9]–9 (FHB)+23–27; teeth minute, conical and recurved in jaws, granular elsewhere; a narrow band of teeth in upper jaw, a narrower band in lower jaw tapering posteriad to an irregular row; an arrow-shaped tooth patch on vomer with a long posterior shaft; a band of teeth on tongue, broader posteriad (FHB); no teeth on palatines.[9]

Head 2.1[18]–2.7,[6] depth 1.1[18]–1.4,[6] pectoral fin 2.0[18]–3.7[6] in SL; snout 1.5[18]–2.2,[6] eye 4.0–5.2,[6] interorbital 4.2–5.4,[18] maxillary 2.7–3.4 in head.[18,26]

Body strongly compressed, outline of head and body trenchant; dorsal profile nearly a straight line from beginning of soft dorsal to a vertical over or behind eye; anterior profile a nearly straight, well inclined line from opposite eye upward, meeting the dorsal profile in a rounded, obtuse angle; ventral profile to anal origin very moderately rounded; profiles at bases of dorsal and anal fins nearly straight lines; snout and lacrimal notably long; mouth small, rather well inclined, superior, lower jaw moderately projecting; maxillary ending well in front of eye; supramaxillary well developed. Anterior part of spinous dorsal with 4 reduced spines connected by a membrane, the first very short, closely adherent to second; posterior part of spinous dorsal with 4 short, stout, pungent, disconnected, widely spaced spines, subequal in length; the 2 anterior disconnected anal spines not evident by about 150 mm, the third with a small procumbent spur at base; dorsal and anal fin lobes much prolonged; increasing in relative length with growth, the first ray often reaching to end of caudal fin or beyond, dorsal lobe usually longer than anal; fold at base of dorsal and anal fins usually poorly developed; [9] caudal fin deeply forked; [18] pectoral fin notably long and falcate; [9] pelvic fin becoming very short, about equal to eye at 200 mm,[18] shorter than eye in larger specimens (FHB). Scales minute, antedorsal area and head scaleless; body nearly all scaled, anterior boundary of scales a rather irregular line, running approximately from origin of first dorsal to upper angle of gill opening. Anterior curve in lateral line moderately high, its chord only a little shorter than straight part of lateral line; scutes obsolescent, some of the posterior scales in straight part with bulges suggesting a keel, but not actually keeled or spinous and not larger than adjacent scales; accessory lateral line ending under origin of spinous dorsal.[9]

Pigmentation: Usually silvery all over (FHB) or golden back, above lateral line, with a metallic bluish tinge first prolonged dorsal and anal fin rays often blackish; n distinctive color marks.[9]

Recognized by very deep body, straight, oblique fore head, and produced anterior rays of second dorsal an anal fins.[18]

Maximum length: Largest reported 483 mm TL.[20]

DISTRIBUTION AND ECOLOGY

Range: In the western Atlantic from Nova Scotia (FHB and Bermuda to Uruguay,[3] including Gulf of Mexico; [2,4] rare in the West Indies (FHB); common from Chesapeake Bay southward.[13] Questioned reports from the eastern Atlantic at Fernando Po, off West Africa.[8]

Area distribution: Chesapeake Bay at Calvert and Talbot counties, Maryland and Cape Charles City,[10] Buckroe Beach, Lynnhaven Roads and Ocean View, Virginia; [1] Ocean City, Maryland; [7] Delaware; [5] Atlantic, Cape May and Ocean counties, New Jersey.[16]

Habitat and movements: Adults—common southward on sandy shores.[4] Occasionally seen around Ocean City harbor piers in late July or August; taken in Chesapeake Bay September–October.[18] Taken in salinities from 8.6–45.2 ppt and temperatures from 16.0–31.1 C; [1] 17 dead or stunned specimens taken in Tampa Bay at 10.4 C.[1]

Larvae—pelagic; taken in Gulf of Mexico and off south Atlantic states in all months except June, October, and December.[2]

Juveniles—frequent shallow inshore areas over sand or mud bottoms (FDM). Taken in late summer and fall uncommonly at New York and Woods Hole; [15] specimens 40–46 mm taken from surf in Delaware July–August; fairly abundant in Gulf of Mexico outside and in lower estuaries of Mississippi in late summer and fall; [17] taken in inside waters in Louisiana July–November; [12] taken off south Atlantic states and in Gulf of Mexico in all months except June, October and December.[2] Taken in salinities from 8.0[12]–33.7,[14] mostly above 20 ppt; [12] taken at temperatures from 15.0–31.9 C.[12]

SPAWNING

Larvae taken in western Atlantic in all months except June, October and December; [2] in Gulf of Mexico larvae abundant mainly in northeast offshore waters in August, suggesting a short spawning period in that area.[2]

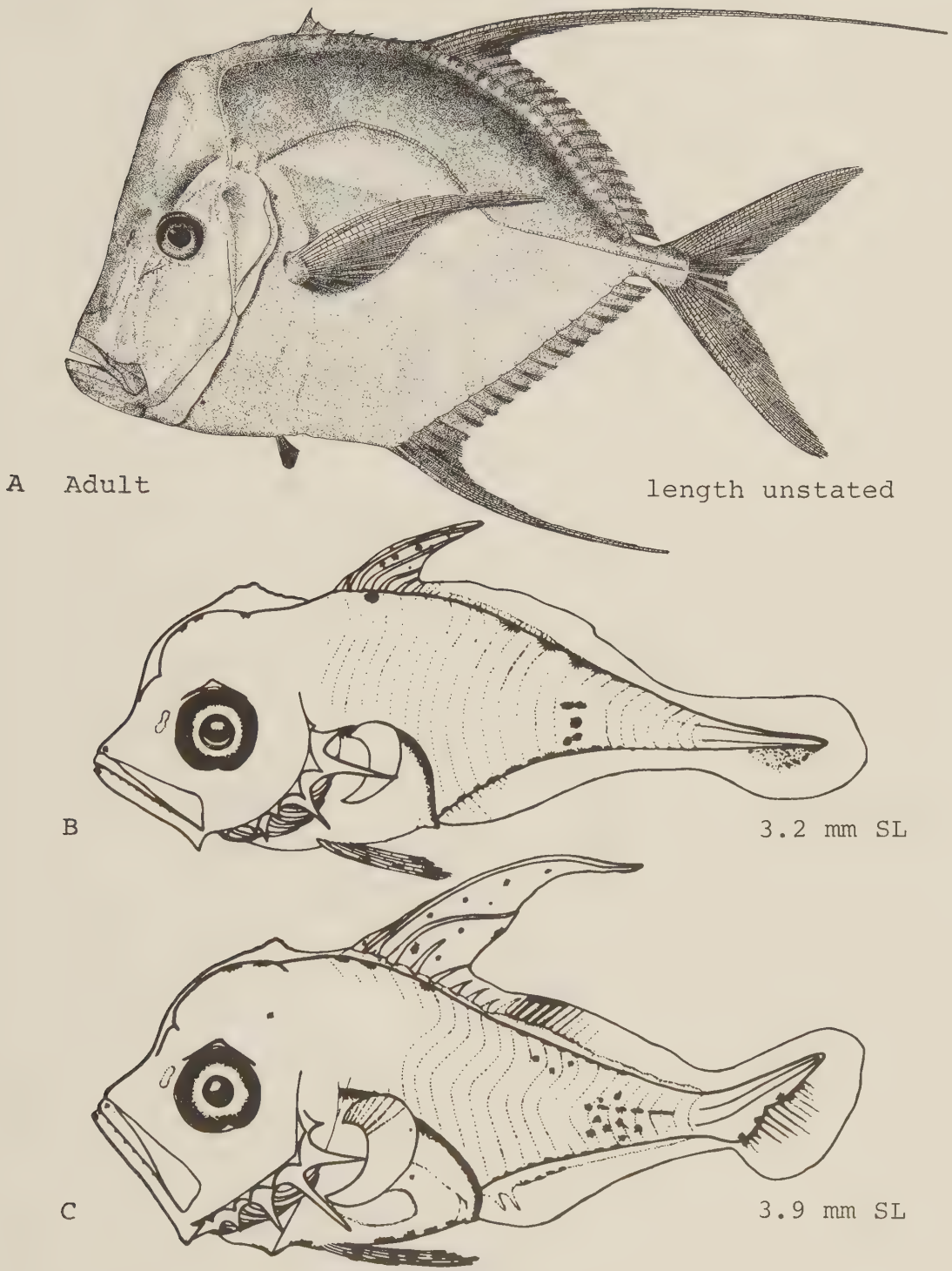

Fig. 44. *Selene vomer,* Lookdown. A. Adult, length unstated. B. Larva, 3.2 mm SL. C. Larva, 3.9 mm SL. (*A, Goode, G. B., 1884: pl. 98. B, C, Aprieto, V. L., 1974: figs. 7 A, B.*)

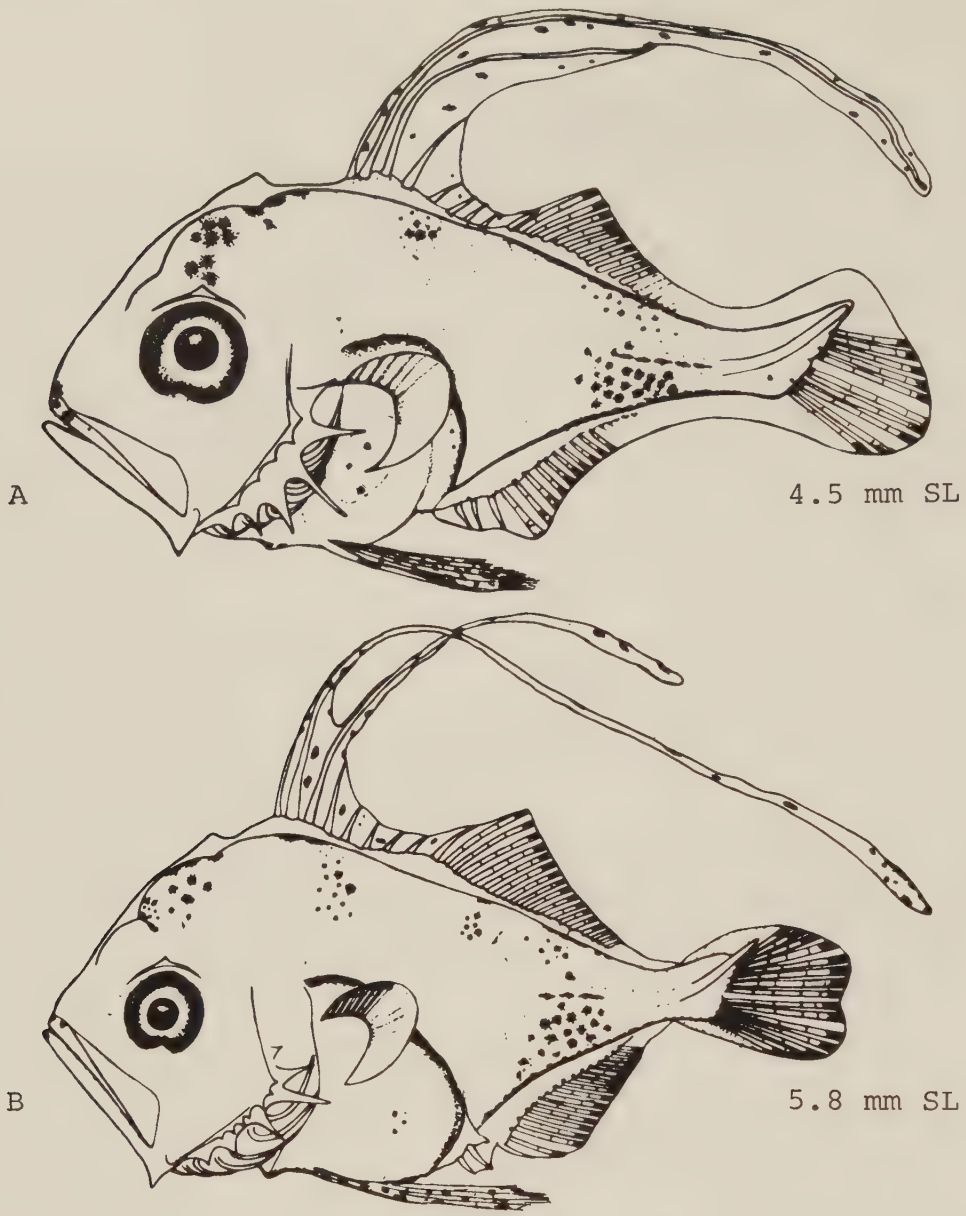

Fig. 45. *Selene vomer*, Lookdown. A. Larva, 4.5 mm SL. B. Larva, 5.8 mm SL. (*Aprieto, V. L., 1974: figs. 7 C, D.*)

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

About 2.5 to 9 mm.

Sequence of fin formation as follows: 1) pelvic; 2) first dorsal; 3) second dorsal, caudal and anal; 4) pectoral. (Advanced development of dorsal and pelvic fins is the earliest observed among carangid larvae.) First 3 dorsal spines ossify at 2.5 mm, second and third progressively increase in length throughout larval period, forming extremely long filaments (about twice length of body at metamorphosis). Rudiments of anal fin discernible at 3.2

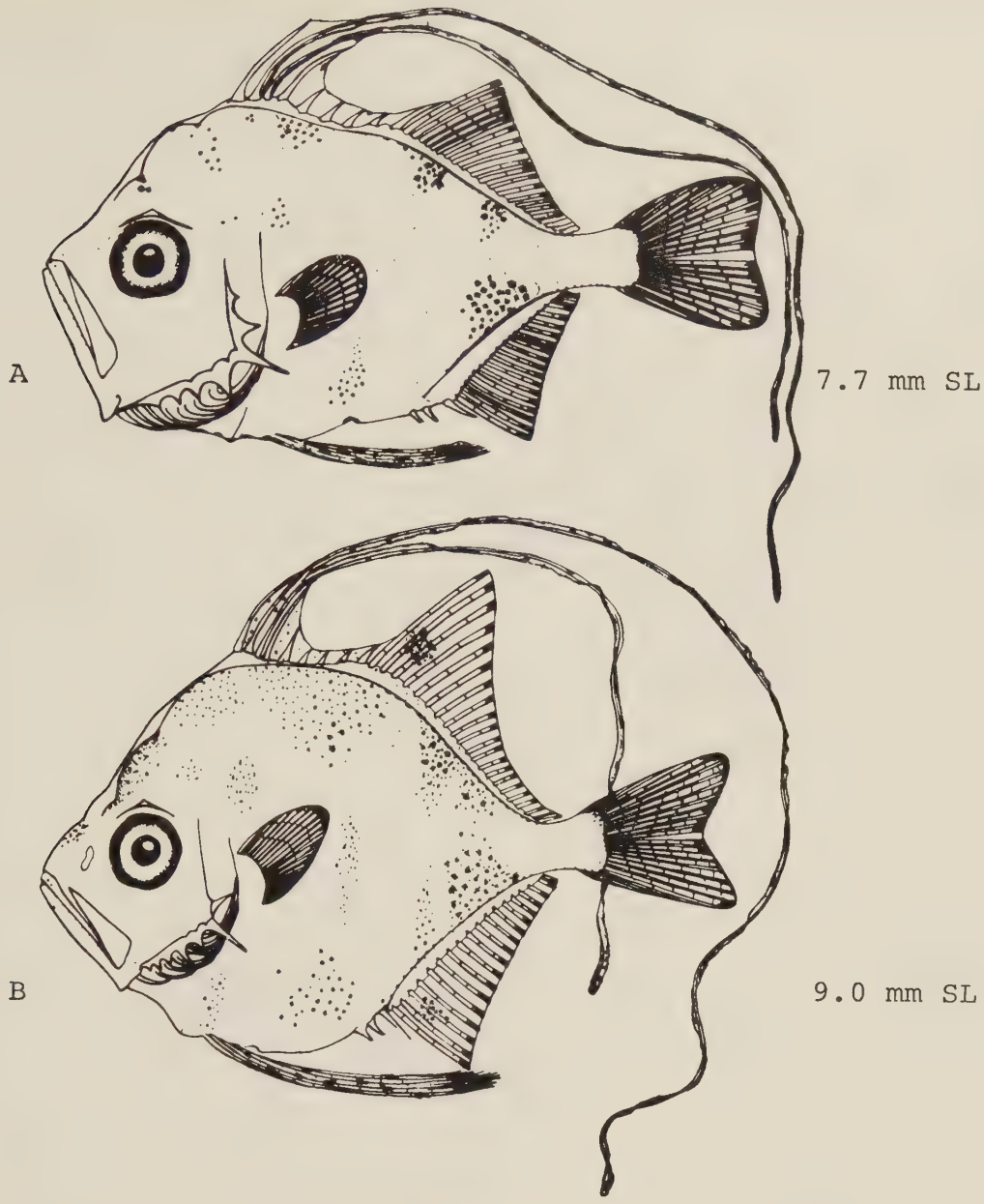

Fig. 46. *Selene vomer,* Lookdown. A. Larva, 7.7 mm SL. B. Juvenile, 9.0 mm SL. (*Aprieto, V. L., 1974: figs. 7 E, F.*)

mm; rays ossify at 4–5 mm; full complement present at 6 mm. Development of caudal fin similar to that of *Elagatis bipinnulata.* Pectoral fin bud formed at 2.5 mm; rays differentiated at 5–6 mm. Pelvic fin fully formed at 2.5 mm, steadily increasing and at metamorphosis extending beyond origin of anal fin. Supraorbital and supraoccipital crests well developed to about 5 mm, thence gradually resorbed and vaguely visible at metamorphosis. Two rows of spines present on preopercle; marginal spines consist of 4–7 long and strong spines; lateral surface spines smaller and limited to lower arm; all preopercular spines resorbed at transformation. First haemal spine much enlarged and pressed against an equally enlarged haemal spine. Scales absent.[2]

Pigmentation: At 2.5–5.0 mm a few melanophores developed on tips of jaws, head, sides of body, pelvic fin, dorsal fin and base of caudal fin; earliest patch of melanophores formed on lower side of body anterior to caudal peduncle; melanophores also present along base of dorsal and anal fins and along lateral midline. In older larvae, melanophores gradually proliferating all over body and forming discrete patches which develop

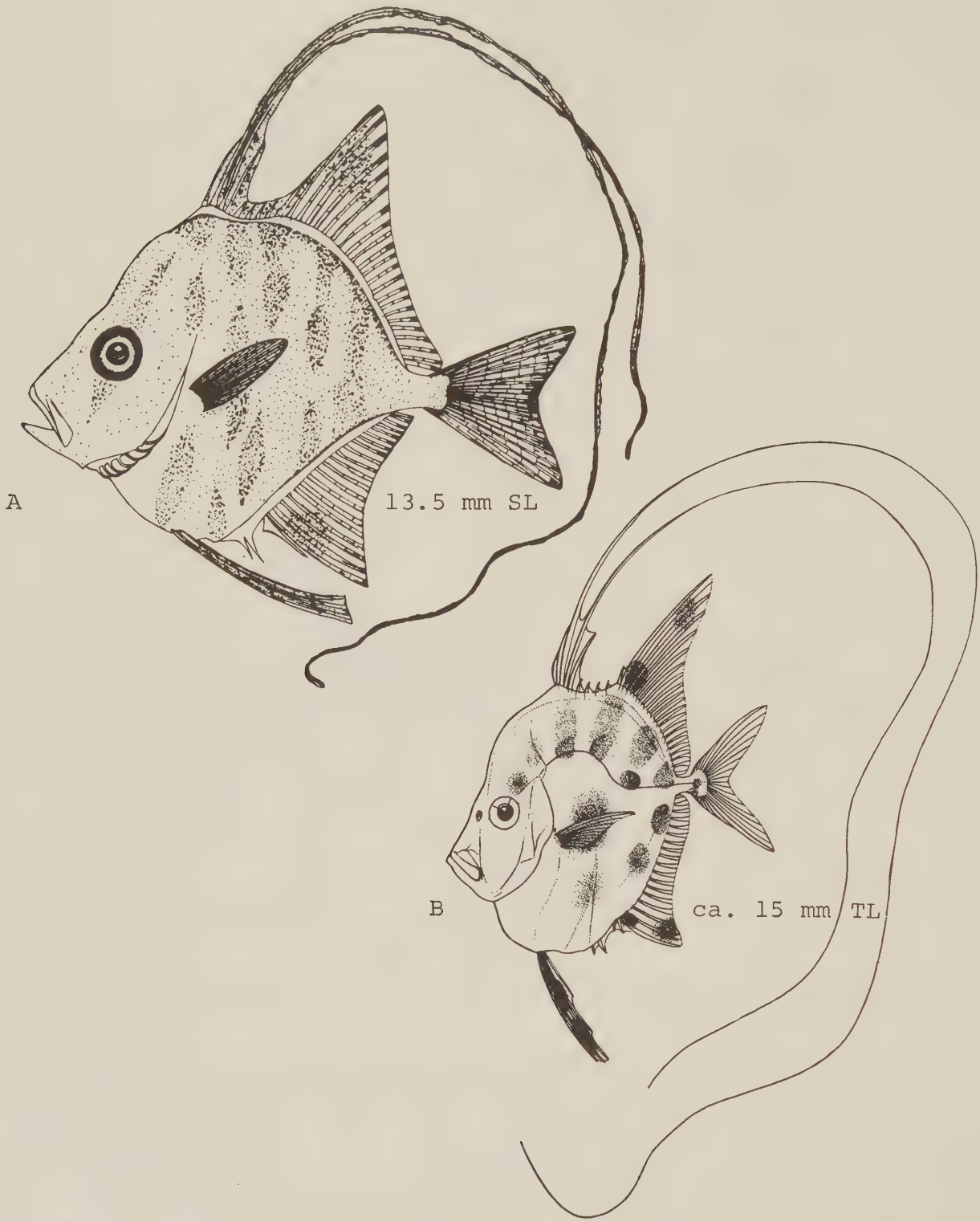

Fig. 47. *Selene vomer*, Lookdown. A. Juvenile, 13.5 mm SL. B. Juvenile, ca. 15 mm TL. (*A, Aprieto, V. L., 1974. B, Fowler, H. W., 1936: fig. 318.*)

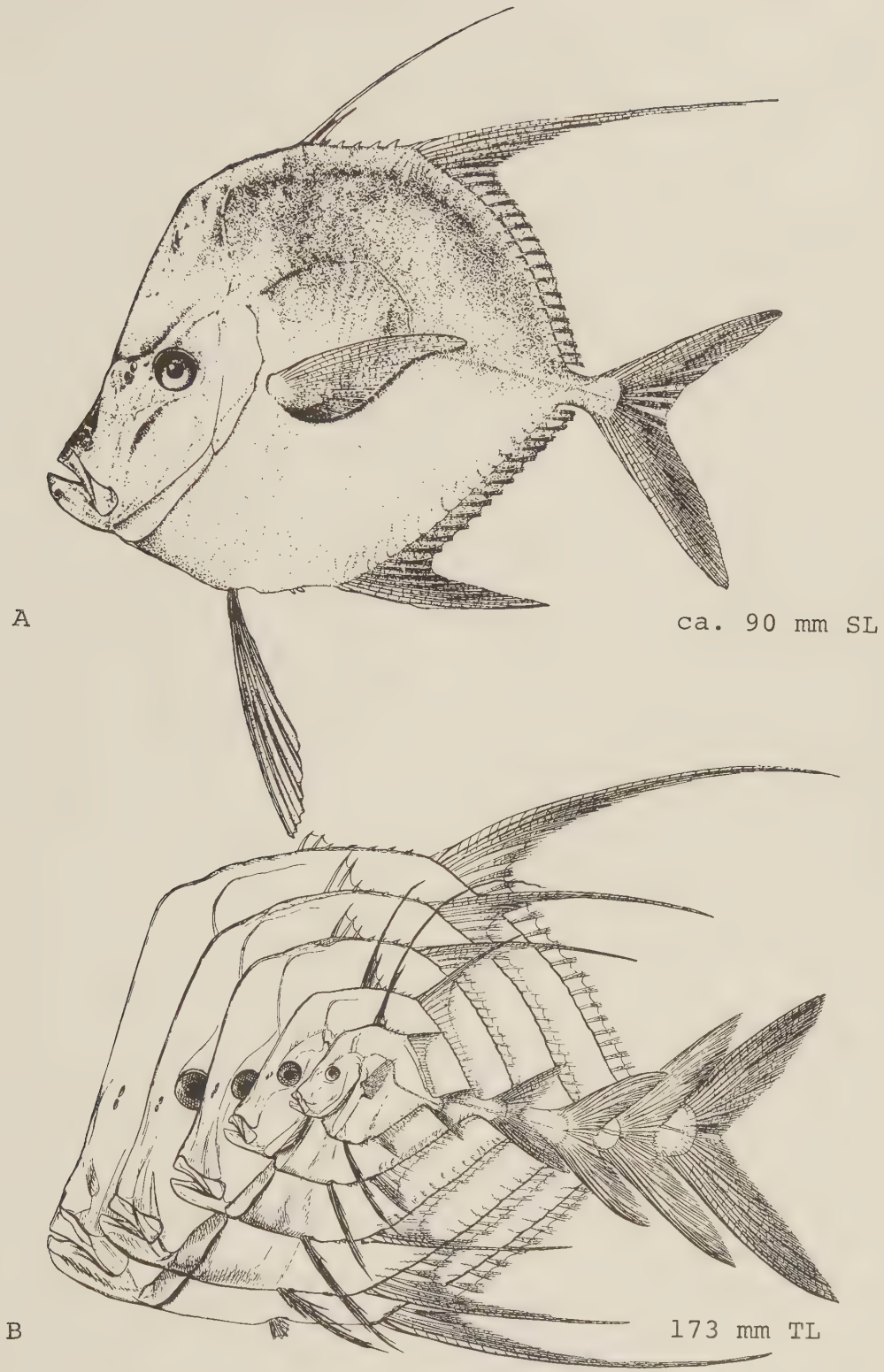

Fig. 48. *Selene vomer,* Lookdown. A. Juvenile, ca. 90 mm SL. B. Five juveniles, showing basic change in body form with growth, from front to back: 41 mm TL, 76 mm TL, 90 mm TL, 110 mm TL, 173 mm TL. (*A, Evermann, B. W., and M. C. Marsh, 1902: fig. 34. B, Lütken, C. F., 1880: 547.*)

into broad spots at transformation; heaviest concentration of pigment cells comprising those lining wall of peritoneum; regularly spaced melanophores, similar to those in *Elagatis bipinnulata*, present along midventral line in trunk region.[2]

JUVENILES

Full complement of all fin rays (including procurrent caudal rays) present at 9 mm.

First and fourth dorsal spines of moderate length, second and third excessively produced as filaments, second longer than third, about twice as long as body or longer at its maximum; this filamentous extension lost with growth. Two anterior disconnected anal spines moderately developed at 32 mm, disappearing by about 150 mm; third anal spine with a forward directed spur near base, nearly disappearing with growth.[9]

Recognized by filamentous second and third dorsal spines, greatly produced pelvic fin and 4 or more dusky cross bars (all juvenile characters which disappear in adult).[18] Distinguished from *Alectis ciliaris* by the eye being more than an eye diameter from upper edge of mouth (less in *A. ciliaris*), and by the higher gill raker count (23–27 on lower limb vs. 14–16).[19]

Pigmentation: Body with 4–5 faint, dusky, interrupted bands on body and a band running from spinous dorsal through eye [9,18] (in life these bands apparently yellow at 90 mm [18]); pelvic fin rays and prolonged second and third dorsal spines black.[9] At 90 mm produced rays of soft dorsal also black, anterior shorter rays dusky yellow, posterior rays plain; produced rays of anal fin dusky yellow; caudal fin tinged with yellow.[18]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Seriola dumerili (Risso), Greater amberjack

DULTS

. VIII–I,[3,4,5] 28[9]–35[3] (usually 31–33[5]); A. II–I,[3,4] 18–
2 (mean 20.0[3]); C. 9+8, procurrent rays 9–13+10–11;[9]
19–22;[4] V. I, 5;[6] lateral line scales 141–163;[4] verte-
rae 10+14;[9] gill rakers 2–3+11–13 (decreasing in num-
er with growth); teeth subequal, in moderately broad
ands in jaws and on palatines; teeth on vomer in an
nchor shaped patch; tongue with a moderate band of
eth.[4]

n specimens 390–590 mm, depth 3.3–3.7 in SL. In speci-
ens larger than 590 mm, depth 3.7–4.5 in SL.[5] In
ecimens 205–440 mm head 3.2–3.6 in SL; snout 2.4–
8, eye 4.4–5.8, maxillary 1.9–2.2 in head.[10]

ody spindle shaped, moderately deep; caudal peduncle
mpressed to subterete,[4] with a distinct, wedge-shaped,
eshy, lateral keel medially on each side;[6] a crescent
naped pit on the dorsal and ventral aspect of caudal
eduncle near caudal fin base;[4] snout moderately long,
otuse; adipose eyelid moderately developed posteriorly;
axillary reaching to about middle of eye;[6] supramaxil-
ry present. Scales small; antedorsal area scaled to a
ertical between eye and preopercular margin, cheek
nd upper part of opercle scaled; greater part of opercle
nd rest of head scaleless; caudal scaled, other fins scale-
ss. Anterior curve of lateral line long and low, merg-
g gradually with the posterior straight part, without
utes; accessory lateral line very short. First dorsal fin
educed, low, the anterior spines connected by a mem-
rane, the last 2 spines partly disconnected; first dorsal
n retractable into a shallow groove; last dorsal spine
nd first anal spine often covered by skin in larger speci-
ens;[4] second dorsal fin base 1.5–1.7 times as long as
nal fin base;[5] dorsal and anal fin lobes moderate; anal
n with first 2 spines disconnected; pelvic fin extending
ore than half distance from base to soft anal origin;
ectoral fin not reaching quite to end of pelvic.[4]

gmentation: Body dark above, lighter along sides with
vender and golden tints; sometimes with an amber[5,6]
brassy[13] stripe from eye to tail; silvery white ven-
ally; dark dorsal area may be brownish, olivaceous, or
dark steely blue;[5,6,10] an olivaceous straight nuchal
nd from eye to origin of dorsal fin.[5,6] When seen alive
clear water, often look purplish.[6]

aximum length: Largest recorded 1803 mm.[13]

ISTRIBUTION AND ECOLOGY

ange: In the western Atlantic from Cape Cod, Massa-
usetts and Bermuda to Brazil; in the eastern Atlantic
om the Mediterranean to the west coast of Africa.[5,6]

Area distribution: Lower Chesapeake Bay at Lynnhaven and Kiptopeke, Virginia;[2,10] Ocean City, Maryland;[12] Atlantic, Cape May, Monmouth and Ocean counties, New Jersey.[11]

Habitat and movements: Adults—pelagic, but have been taken on bottom as deep as 450 m.[5] Rare to casual in Massachusetts and New York in summer.[8]

Larvae—pelagic, offshore, but less strictly so than adults.[7]

Juveniles—pelagic, offshore, but less strictly so than adults;[7] below 50 mm apparently use *Sargassum* as a refuge;[13,15] Florida current specimen 50–100 SL taken near patches of *Sargassum* and in groups of about 20 to 60 fish.[16]

SPAWNING

Location: Apparently occurs in offshore oceanic waters.[14]

Season: Probably in fall, winter[14] and spring;[13,14,15] at Beaufort specimens 4–12 mm taken in August and September, indicating a summer spawning;[7] ripe female, and eggs and larvae taken in Mediterranean in late June.[1]

Note: *The concept of the species of* Seriola *was inadequate at the time the descriptions of Sanzo, 1933*[1] *and Hildebrand and Cable, 1930*[7] *were published* (FHB). *For this reason, the following descriptions of developmental stages, based largely on these two publications, may be inaccurate.*

EGGS

Yellow, spherical, transparent, 1.04–1.12 mm in diameter; membrane striated, perivitteline space narrow; yolk large, irregularly vesiculated; one oil globule, colorless, .28 mm in diameter.[1]

EGG DEVELOPMENT

First division occurs a little more than 30 minutes after artificial fertilization. Gastrulation proceeds rapidly, and at 10 hours after fertilization, blastopore closed; embryo reaches halfway around meridian, otocyst formed and segmentation occurring. At 30 hours after fertilization tail free, heart beginning to beat, a secondary otic capsule forming, about 20 myomeres evident; black and yellow pigment present in head region; oil globule with a number of stellate chromatophores. By end of second day, eggs beginning to hatch.[1]

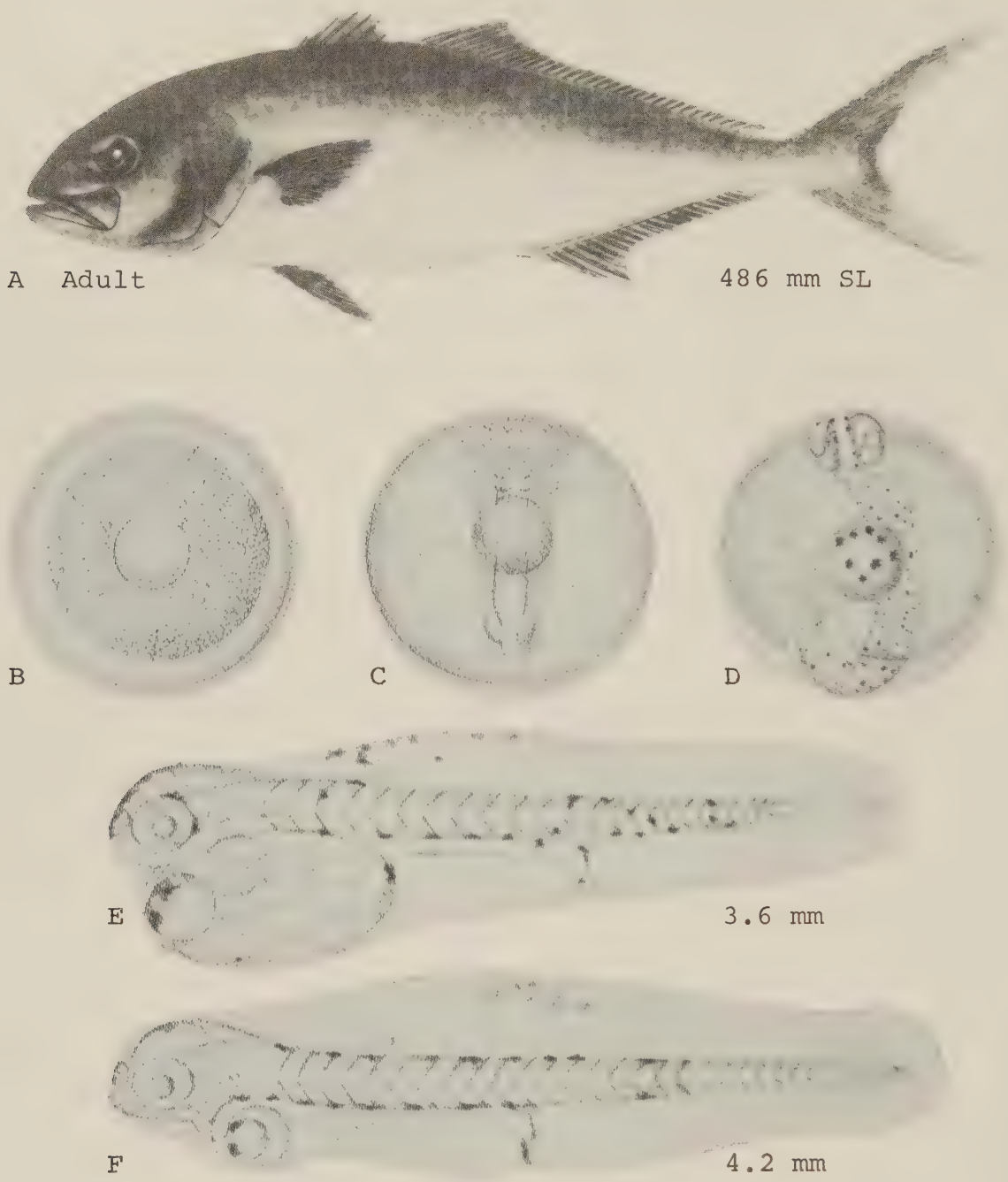

Fig. 49. *Seriola dumerili,* Greater amberjack. A. Adult, 486 mm SL. B-D. Eggs. E. Yolk-sac larva, 3.6 mm. F. Yolk-sac larva, 4.2 mm. (*A, Berry, F. H., MS. B-F, Sanzo, L., 1933: figs. 1–5.*) *All stages other than adult illustrated here should be considered putative as the species of* Seriola *were not fully understood at the time of these descriptions* (FHB).

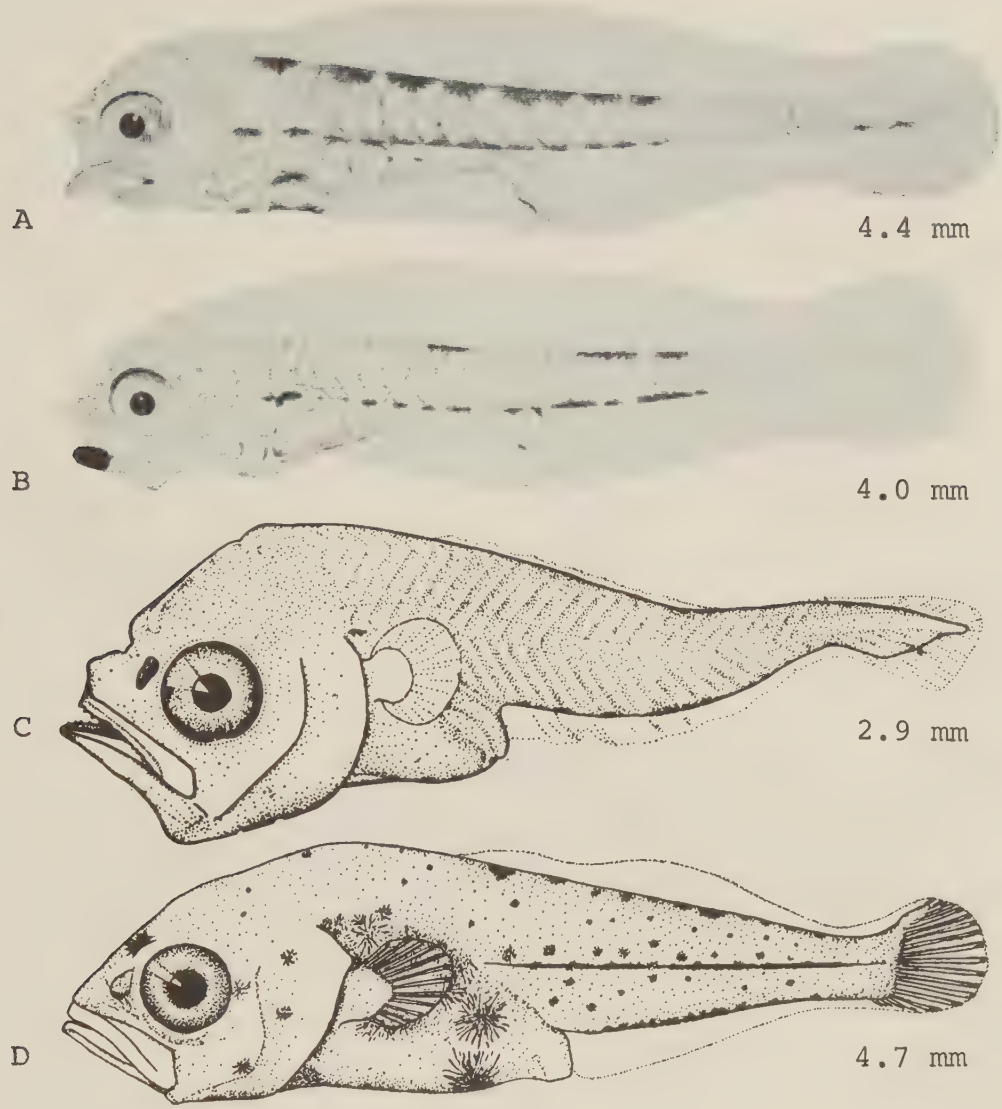

Fig. 50. *Seriola dumerili,* Greater amberjack. A. Yolk-sac larva, 4.4 mm. B. Yolk-sac larva, 4.0 mm. C. Larva, 2.9 mm. D. Larva, 4.7 mm. (*A-B, Sanzo, L., 1933: figs. 6–7. C-D, Hildebrand, S. F., and L. E. Cable, 1930: figs. 73–74.*) *All stages illustrated here should be considered putative as the species of* Seriola *were not fully understood at the time of these descriptions* (FHB).

YOLK-SAC LARVAE

3.5 mm at hatching.

Yolk sac oval, reaching forward to below head and falling short of anus posteriorly; yolk vesiculated; mouth not open; no branchial arches; gut straight; olfactory fossa, otocyst, and tapetum lucidum evident; 10 preanal + 14 postanal myomeres. At 4.2 mm (second day after hatching) yolk sac reduced, but oil globule still evident. At 4.4 mm (third day after hatching) yolk sac very small; mouth open; pectoral bud well developed; black pigment marks off dorsal and ventral profiles of trunk. By seventh day yolk sac completely absorbed; hypurals and some fin rays forming.[1]

Pigmentation: Melanophores sparsely and irregularly spaced on body and oil globule; yellow pigment on head, oil globule, along gut, on caudal trunk, and more characteristically on margin of dorsal fin fold and on abdominal trunk; some yellow on ventral fin fold just in front of anus. At 4.2 mm black pigment on trunk along dorsal and ventral profiles, eyes with some pigment. At 4.4 mm yellow pigment present on fin fold, anterior part of trunk, and behind anus. Between the fourth and seventh day after hatching black pigment on dorsal profile of trunk reduced, but about the same as ventral profile; yellow pigment still present on fin fold, becoming diffuse on trunk.[1]

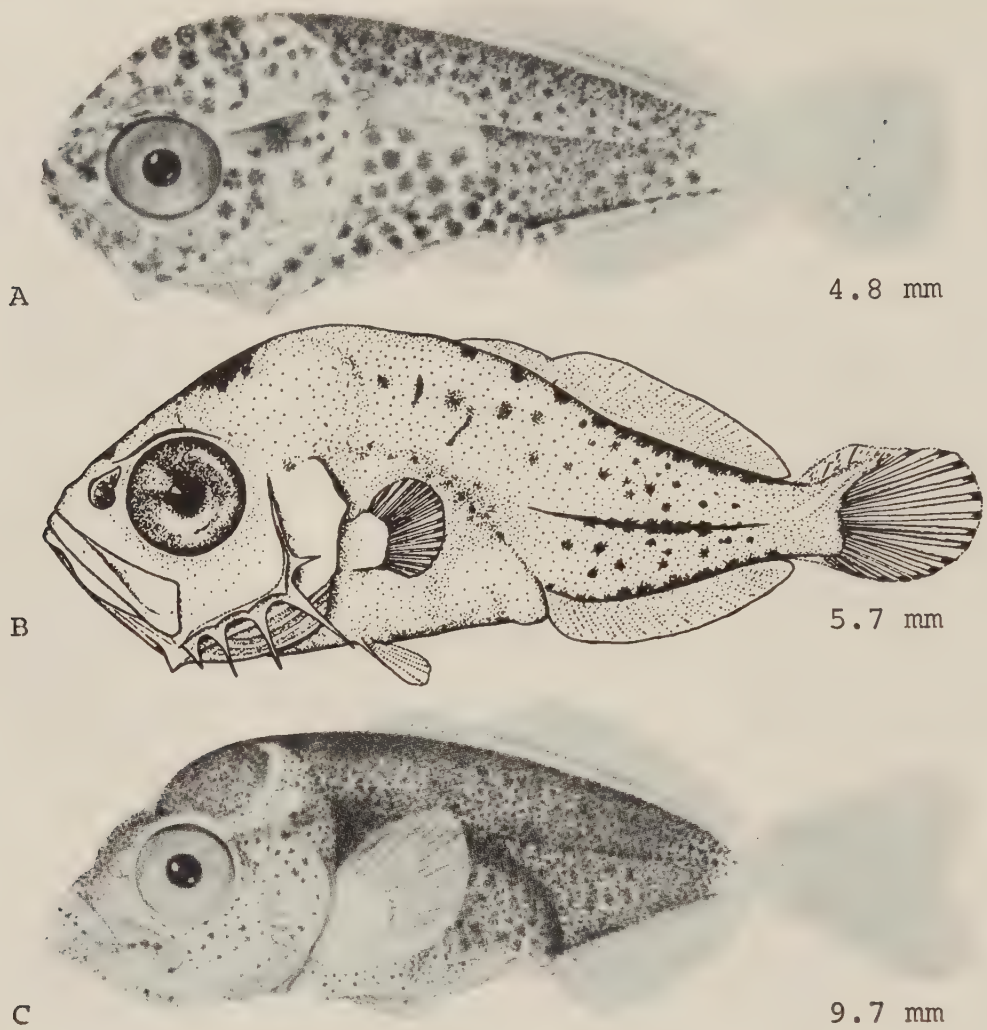

Fig. 51. *Seriola dumerili,* Greater amberjack. A. Larva, 4.8 mm. B. Larva, 5.7 mm. C. Larva, 9.7 mm. (*A, C, Sanzo, L., 1933: figs. 8–9. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 75.*) *All stages illustrated here should be considered putative as the species of* Seriola *were not fully understood at the time of these descriptions* (FHB).

LARVAE

About 2.0–4.0 mm to about 10.0 mm.

At 4.8–6.0 mm snout short, mouth small,[1] oblique; anus at about mid-body; [7] dorsal and anal fin rays developing; [1,7] some caudal rays evident; [7] pectoral fin broad, slightly rounded, membranous,[1] but with some rays developing; [7] pelvic fin bud present; [1,7] preopercular spines well developed,[7] 4 on anterior margin and 3 on posterior margin.[1]

Pigmentation: At about 5 mm body strongly pigmented with black; rear portion of caudal trunk transparent; [1] a very narrow dark lateral stripe; [7] large stellate chromatophores present on head and abdominal region; [1,7] punctiform pigmentation present on rest of trunk; a few very small spots on caudal fin, other fins without pigment. At 6 mm pigment more diffuse; a dark lateral strip present on most of caudal length; a concentration of pig ment along dorsal and anal bases; particularly distinc tive is a cluster of large black chromatophores on nape.

JUVENILES

By about 10 mm all fins with full complement of rays

Preopercular spines still prominent but relatively smaller At 30 mm first anal spines well separated from rest o fin; lateral line scalation complete; preopercular spine absent. Between 50–100 mm 21–24 gill rakers; betwee about 100–200 mm 14–20 gill rakers; between abou 200–400 mm 13–16 gill rakers.[7]

Pigmentation: At 10 mm body quite dark brownish in color with scattered darker chromatophores; dark lateral stripe and pigment along dorsal and anal fins less distinct; dorsal surface of head profusely dotted with black.[7] At 17 mm pigment about the same except a diffuse yellow pigmentation is superimposed on caudal trunk; caudal fin completely devoid of pigment; dorsal and anal fins, except for short posterior portions, with very small black spots and yellow along interradial membranes; pelvic also with black and yellow along interradial membranes. At about 25–30 mm transverse dark bands beginning to form by concentration of scattered chromatophores [1,7] as follows: first (nuchal band) confined to cephalic region, second at about level of first dorsal, third at about level of second dorsal, fourth midway along second dorsal, fifth about end of second dorsal; [1] bands do not extend into webs of dorsal and anal fins; a yellow to light brown cast between fins and on tail; [6] punctiform xanthophores still present on body; bluish pigment along back; caudal without pigment except on base; [1] no trace of dark lateral band remaining.[7] At 34 mm blue pigment extends laterally to overlay yellow pigment; first pigment (nuchal) band runs forward to back part of eye, second begins just ahead of spinous dorsal origin and passes near base of pectoral, third begins at origin of second dorsal and splits ventrally to form 2 bands, fourth and fifth bands remain the same, a sixth band now present on caudal peduncle, and a seventh lies partly on caudal trunk and on base of caudal fin; caudal without pigment except for streaks of yellow along dorsal and ventral margins; posterior portions of dorsal and anal fins remain without pigment; pectoral still without pigment except for a few scattered black spots on base.[1] Bars lost at about 175 [6]–200 mm; [5] body mostly yellowish, back olivaceous and underparts silvery; usually a distinct yellow band down middle of side, fins and tail mostly yellowish brown; nuchal bar olivaceous, washed with yellow; essentially the adult coloration.[6]

GROWTH

No information.

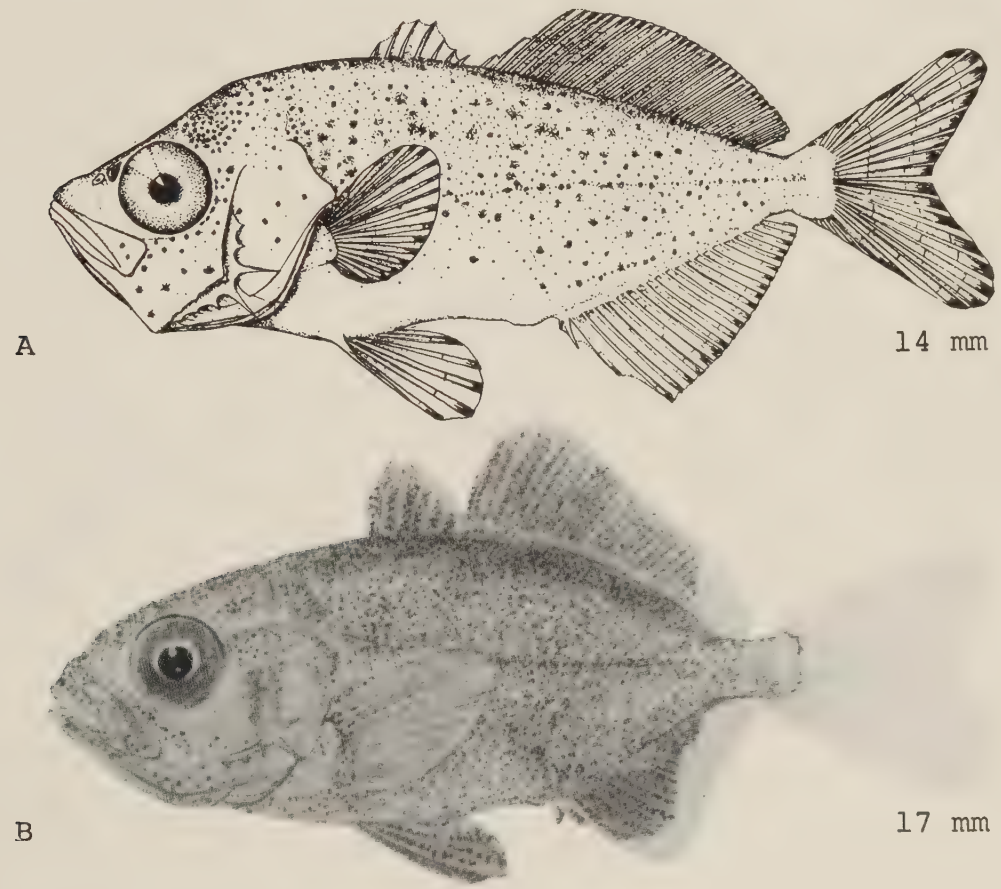

Fig. 52. *Seriola dumerili,* Greater amberjack. A. Juvenile, 14 mm. B. Juvenile, 17 mm. (A, *Hildebrand, S. F., and L. E. Cable, 1930: fig. 76. B, Sanzo, L., 1933: fig. 10.) All stages illustrated here should be considered putative as the species of* Seriola *were not fully understood at the time of these descriptions* (FHB).

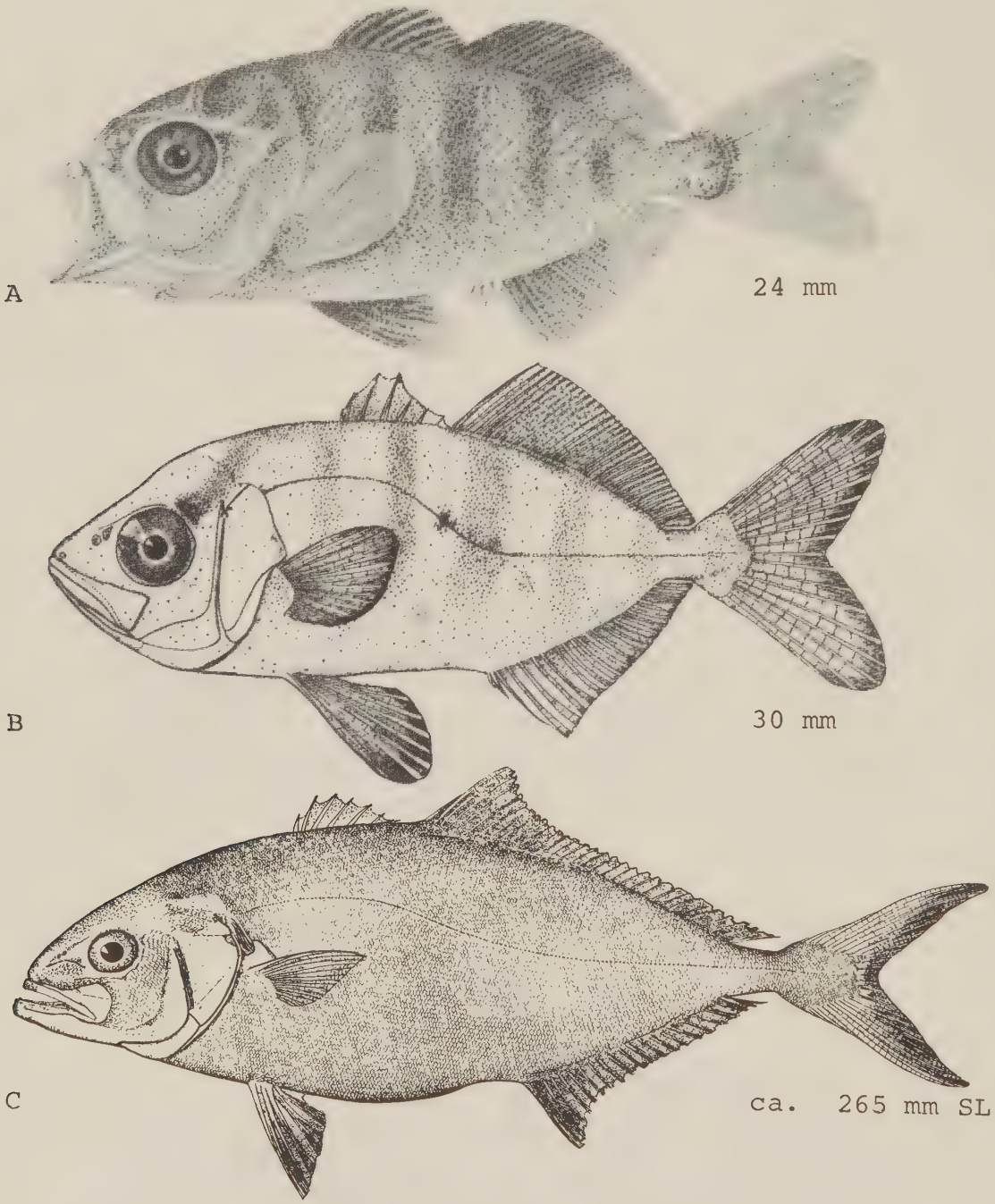

Fig. 53. *Seriola dumerili,* Greater amberjack. A. Juvenile, 24 mm. B. Juvenile, 30 mm. C. Juvenile, ca. 265 mm SL. (*A, Sanzo, L., 1933: figs. 11–12. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 77. C, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 381.*) *The 2 smaller juveniles illustrated here should be considered putative as the species of* Seriola *were not fully understood at the time of these descriptions* (FHB).

AGE AND SIZE AT MATURITY

May be mature by 330 mm.

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Seriola fasciata (Bloch), Lesser amberjack

ADULTS

D. VIII–I, 28–33 (mean 30.5); A. II–I, 17–20 (mean 19.0);[3] P. 19–20;[1] V. I, 5;[4] vertebrae 10+14;[8] lateral line scales 129–134;[1] total gill rakers 23–26;[3] teeth minute, in a band in upper and lower jaws, broadest at symphysis and tapering posteriorly; large tooth patch on vomer, the anterior edge triangular, moderately rounded laterally and moderately constricted to a long, narrow shaft, tapering posteriorly; palatines with a broad tooth patch, rounded anteriorly and pointed posteriorly, numerous small irregular patches following palatines; tongue with a median elongated tooth patch and numerous small irregular patches scattered over rest of dorsal surface.[8]

Depth 3.3–3.9, head 3.4–4.0 in FL; eye 2.1–4.1, pectoral fin 1.8–2.0 in head.[8]

Body elongate, moderately deep and slightly compressed; dorsal profile slightly more convex than ventral; head profile slightly sloping; maxillary moderately broad distally, reaching about to posterior margin of pupil. Scales small, cycloid, covering most of body; on head only on upper part of opercles and on cheeks behind and below eye. Lateral line slightly arched to below middorsal soft rays and straight posteriorly; scutes absent. First or eighth spine of first dorsal fin sometimes minute; second dorsal and anal fin lobes short, the second dorsal lobe about 8–8.5 in FL; caudal peduncle with a moderate keel and a dorsal and ventral groove; pelvic fin a little longer than pectoral.[8]

Pigmentation: Fresh specimens dark dorsally (pinkish or violet), lighter laterally, white or silvery ventrally; faint, dark nuchal band may be present; a faint, narrow, lateral amber stripe extending back from eye may be present; dorsal fin dusky (olive); tip of second dorsal lobe clear or whitish; anterior base, distal margin, and lobe of anal fin white, rest of fin dusky to dark; caudal fin dusky to dark with a lighter, narrow posterior margin; pectoral fin nearly clear to dusky (olive); pelvic fin white with most of dorsal surface dusky (olive).[8]

Adults only recently discovered and identified; probably previously confused with other 3 sympatric species of *Seriola*.[8]

Maximum size: Largest recorded 675 mm FL, 4.6 kg.[8]

DISTRIBUTION AND ECOLOGY

Range: In the western Atlantic from Massachusetts and Bermuda to Cuba including Gulf of Mexico,[2] one specimen recorded from La Guaina fish market in Venezuela;[8] taken well offshore in Florida Current and Gulf Stream;[2] very rare[3] (records doubtful[2]) in easter Atlantic.

Area distribution: Chesapeake Bay.[5]

Habitat and movements: Adults—apparently near or o bottom in about 55–125 m.[8]

Larvae—no information.

Juveniles—smaller juveniles epipelagic in oceanic or off shore neritic waters; larger juveniles pelagic or benthi in shelf waters.[8] Two specimens (47 and 54.1 mm) take in late summer and fall off Florida;[6] a single specime 46.9 mm SL taken under *Sargassum* in Florida Current.

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Specimens described 40–260 mm.

Dark nuchal bar running upward and backward from eye, curving sharply up to meet nape well anterior to first dorsal fin[4,8] (nuchal bar of other species of *Seriola* runs straight back from eye to dorsal origin[4]); body with 7 dark bars, irregular and broken, the third through seventh extending into second dorsal and anal soft ray membranes; a small dark eighth bar at end of caudal peduncle and a dark rounded spot on medial caudal fin rays, caudal fin otherwise clear.[8]

GROWTH

No information.

AGE AND SIZE AT MATURITY

Probably mature at or near 430–470 mm FL.[8]

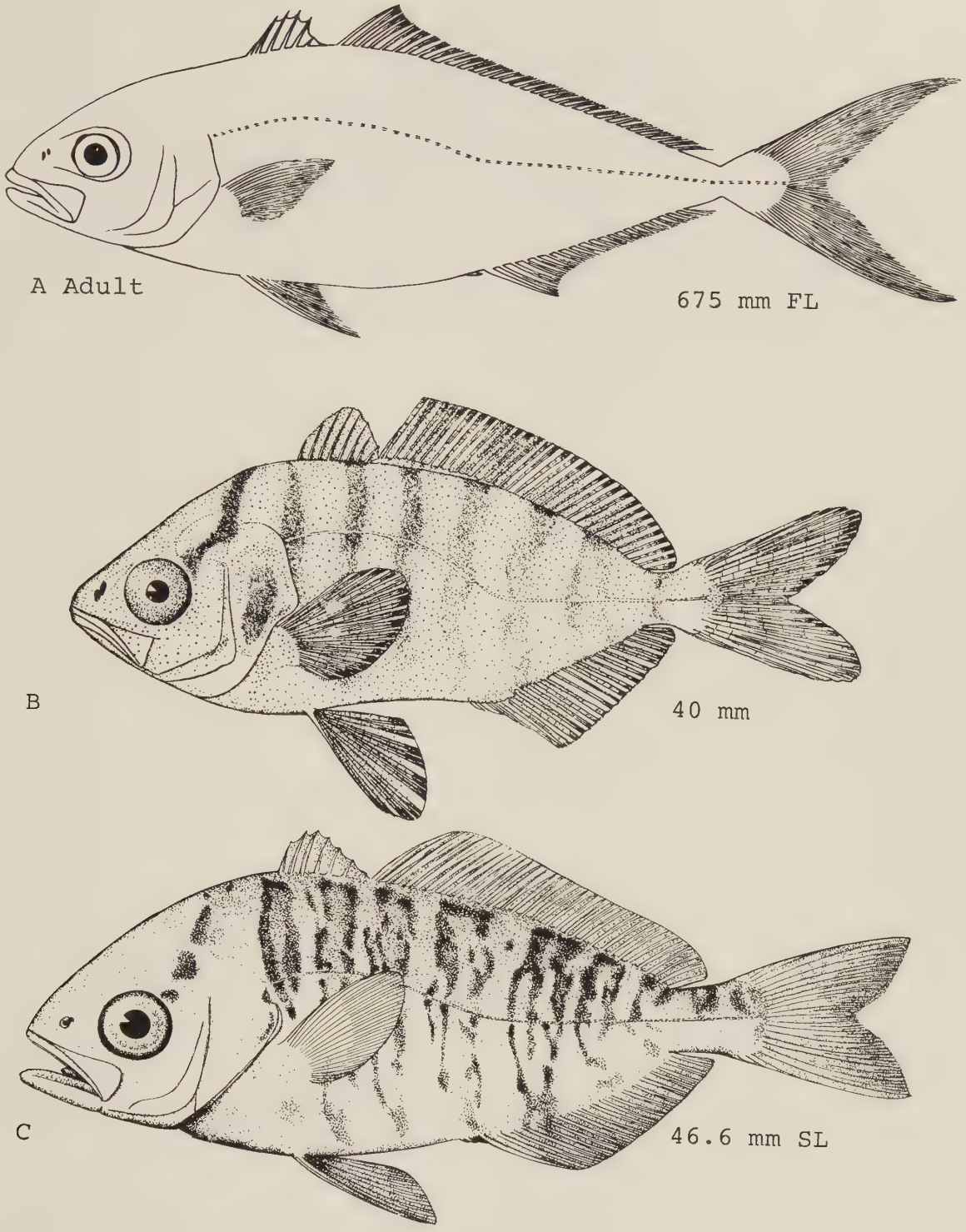

Fig. 54. *Seriola fasciata,* Lesser amberjack. A. Adult, 675 mm FL. B. Juvenile, 40 mm. C. Juvenile, 46.6 mm SL. (*A, Berry, F. H., MS. B, Hildebrand, S. F., and L. E. Cable, 1930: fig. 78. C, Ginsburg, I., 1952b: fig. 1.*)

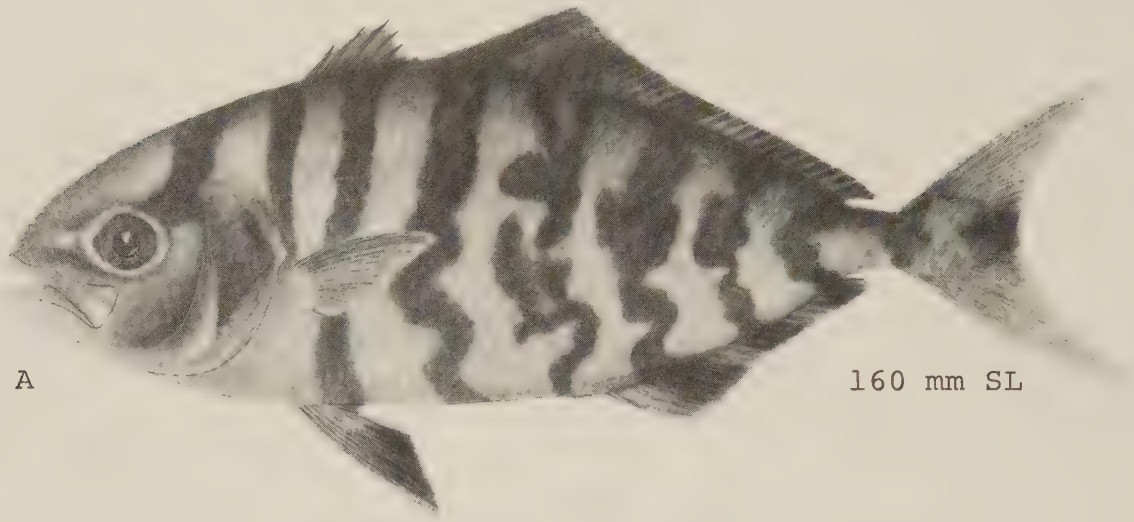

Fig. 55. *Seriola fasciata,* Lesser amberjack. A. Juvenile, 160 mm SL. (*Berry, F. H., MS.*)

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8. Berry, F. H., MS.

Seriola rivoliana Valenciennes, Almaco jack

ADULTS

D. VII [2,3] (rarely VIII [2])–I, 27–33 [2,3] (usually 28–32 [2]); A. II (may be covered by skin in large individuals)–I,[2] 18 [3]–22; [2,3] C. 9+8, procurrent rays 11–13+8–12; [8] P. 19–22; [1] V. I, 5; [4] lateral line scales 122–143; [9] vertebrae 10+14; total gill rakers on first arch 24–28 to about 390 mm, 21–25 in larger specimens, as few as 16 [9]–18 in very large specimens; [2] teeth as in *S. dumerili*.[1]

Depth 2.7–2.8 in SL to about 390 mm, 2.8–3.1 in SL from about 390–590 mm in SL, 3.1–3.3 mm in SL in larger specimens; [2] height of dorsal fin lobe 3.6–5.0 in SL.[9]

Body spindle shaped, deep; caudal peduncle compressed, the fleshy lateral keel moderate or hardly perceptible; a crescentic pit on dorsal and ventral aspect of caudal peduncle near caudal fin base; [1] anterior profile characteristic, running straight from dorsal fin origin to snout; [4] snout moderately long, obtuse; adipose eyelid moderately developed posteriorly; depth at posterior margin of head subequal to its length or slightly more.[1] First dorsal fin reduced, low, the anterior spines connected by a membrane, the last 2 spines partly disconnected; [1] dorsal and anal fin lobes relatively high; [9] anal fin with first 2 spines disconnected; pelvic fin extending more than half distance from base to soft anal origin; pectoral fin not reaching quite to end of pelvic fin. Scales and lateral line as in *S. dumerili*.[1]

Pigmentation: Body predominantly dusky or brownish or more steely blue or olivaceous; sides frequently with a lavender tint; nuchal band, extending from eye to dorsal fin origin, usually olivaceous with golden reflections.[2,4]

Size: Largest recorded 880 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: Circumglobal; [3] in the western Atlantic from New Jersey and Bermuda to Buenos Aires, Argentina,[2] including the Gulf of Mexico; [1] in the eastern Atlantic from the Mediterranean to the Cape of Good Hope.[9]

Area distribution: Chesapeake Bay; [1,6] Atlantic County, New Jersey.[10]

Habitat and movements: Adults—often seen well offshore, rare in shallow water.[9]

Larvae—no information.

Juveniles—below about 50 mm, appear to use sargassum as a refuge; [5] specimens 18.0–63.2 mm taken in the South Atlantic Bight July–August and October.[7]

SPAWNING

Probably occurs in spring,[5] summer and fall.[7]

EGGS

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Pigmentation: By about 18 mm 5 split and irregular vertical bands on body,[1,2,4] with a dark area at base of caudal sometimes forming a sixth band; [4] first band directly behind head, narrower than others, fifth band a little in front of end of dorsal and anal fins; [1] bands usually narrower and more prominent than those of *S. dumerili;* bands not extending into dorsal and anal fin webbing; a yellow and light brown cast between bands and especially on fins; nuchal band especially prominent, dusky or dusky brown, becoming olivaceous with golden reflections in specimens over about 50 mm.[4] Bands (except nuchal) disappearing at about 170 [4,9]–200 mm.[2]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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8. Miller, G. L., and S. C. Jorgenson, 1973:304.
9. Randall, J. E., 1968:103.

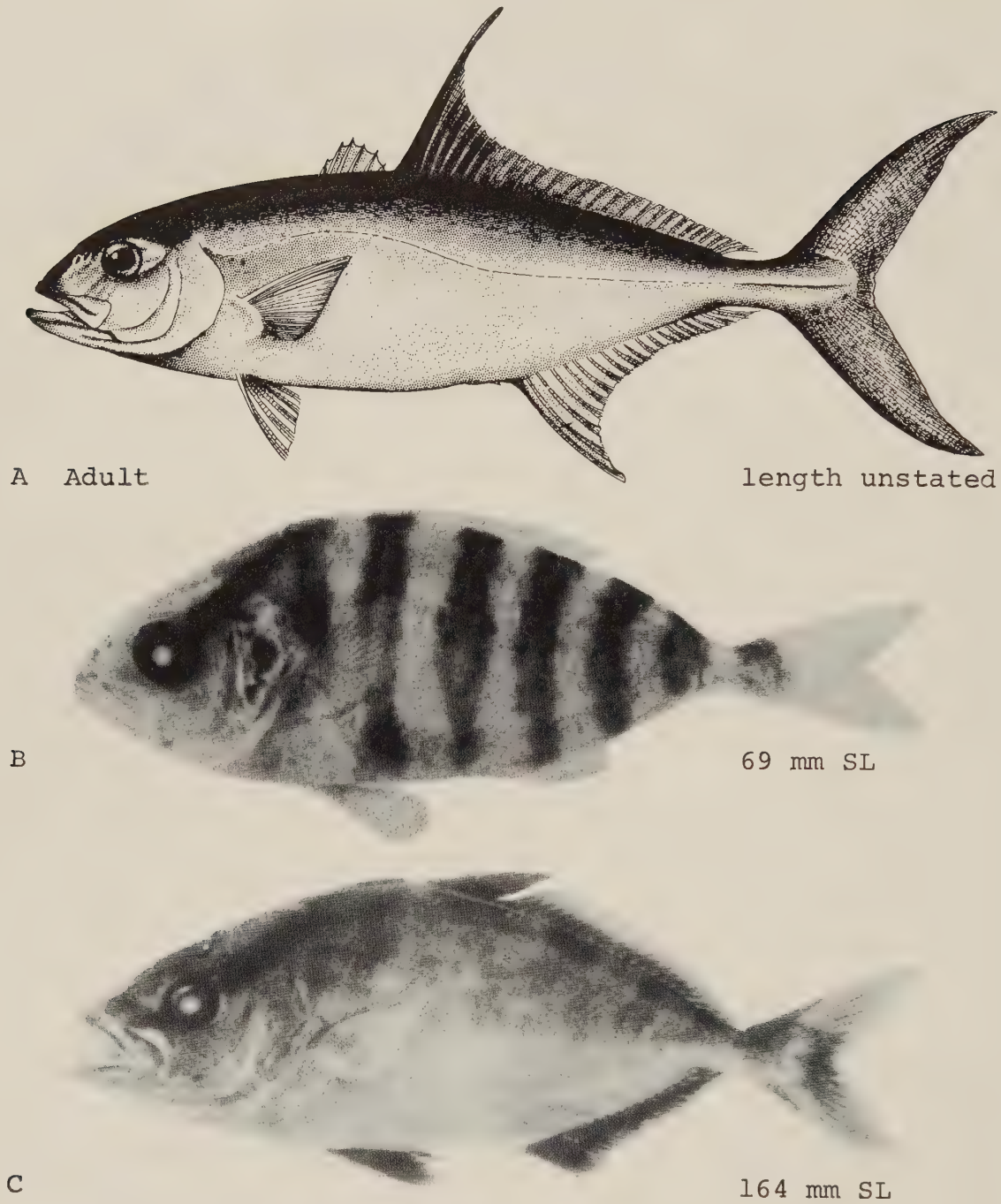

Fig. 56. *Seriola rivoliana,* Almaco jack. A. Adult, length unstated. B. Juvenile, 69 mm SL. C. Juvenile, 164 mm SL. (*A, Berry, F. H., 1965 (in McClane): 16. B-C, Ginsburg, I., 1952b: pl. 2, figs. C, A.*)

Seriola zonata (Mitchill), Banded rudderfish

ADULTS

D. VIII–I, 33–40 [2,3,5] (usually 34–38 [3]); A. II–I,[2,5] 18 [5]–21. C. 9+8, procurrent rays 8–12+9–11; [4] P. 16–21; [1] V. I, 5; [3] lateral line scales 160–187; [5] vertebrae 11+13; [4] total gill rakers 12–16 in large specimens (anterior gill rakers tend to become rudimentary with growth); [2] teeth subequal, in moderately broad bands in jaws and on palatines; teeth on vomer in an anchor shaped patch; teeth on tongue in a band of medium width.[5]

Maximum body depth in specimens about 400–560 mm, 22–25% SL.[3]

Body rather slender, caudal peduncle usually depressed, sometimes subterete,[5] with a fleshy keel as in *S. dumerili;* [3] a crescent shaped pit on dorsal and ventral aspects of caudal peduncle; anus near normal position of first anal spine; [5] mouth medium, terminal; [5] maxillary reaching about to middle of eye; [3] supramaxillary present.[5] First dorsal fin reduced, low, the anterior spines connected by a membrane, the last 2 spines partly disconnected; [1] soft dorsal fin base about twice (1.8–2.2) the anal base (1.5–1.7 in other species of *Seriola*); [3] last dorsal spine may be overgrown in large individuals; [3] first anal spine usually overgrown by about 300 mm; [5] pelvic fin extending more than half distance from base to soft anal fin origin; pectoral fin not reaching to end of pelvic.[1]

Scales and lateral line as in *S. dumerili.*[5]

Pigmentation: Bluish or silvery brown above, paler on the sides, white below; first dorsal fin black; anal fin white at base; pelvic fins black above, pale below; caudal fin dusky green with white tips.[10]

Size: Largest recorded about 610 mm.[2]

DISTRIBUTION AND ECOLOGY

Range: Nova Scotia to Santos, Brazil.[2]

Area distribution: Cape Charles and Cape Henry, Virginia; Ocean City,[5] Worcester County, Maryland; [7] Atlantic, Monmouth, Ocean counties, New Jersey; [8] Indian River Inlet, Delaware.[6]

Habitat and movements: Adults—pelagic, but apparently confined to coastal waters.[3]

Larvae—planktonic, apparently carried along the Florida Current and Gulf Stream and reach northern limits as juveniles; [1] a few specimens 3–5 mm taken in June and August at Indian River Inlet, Delaware.[6]

Juveniles—habits similar to pilotfish (follow sharks and other large fish); often found under jellyfish and drifting weed; [2] in Florida current specimens generally less than 60 mm taken in aggregation of 2 to 30 fish and near patches of *Sargassum,* occasionally with *Caranx ruber* and *Decapterus punctatus;* on at least 2 occasions, seen associated with *Physalia physalia;* [11] taken in all months in Gulf of Mexico and along southern coast of U.S. except February, April, September, and December; [1] common in summer and fall in Massachusetts and New York.[9]

SPAWNING

Occurs mainly in offshore waters in the eastern Gulf of Mexico, Yucatan Channel, Santaren Channel, along edge of continental shelf in Straits of Florida, and in the Carolina Bight off New Brunswick, Georgia; season apparently continuous or possibly in 2 parts (winter-spring and fall).[1]

EGGS

No information.

YOLK-SAC LARVAE

No information.

LARVAE

At least 3.6 mm to about 13–14 mm.

Differentiation of fin rays occurs in following sequence: 1) caudal; 2) first dorsal and anal; 3) second dorsal and pectoral; 4) pelvic. Median finfolds and pectoral buds present at 3.6 mm. Full complement of dorsal rays present at 8–9 mm. Anal fin rays begin to ossify at 5 mm; full complement present at 10 mm. Caudal fin begins to develop at 4–5 mm in a manner similar to *Elagatis bipinnulata;* full complement of principal rays present at 7–8 mm. Pectoral fin rays begin to ossify at 6 mm; full complement formed at 10 mm. Pelvic fin rays differentiate at 7 mm; full complement present at 9 mm. Preanal myomeres 10, postanal 14.[1]

Body depth 30% SL at 3.6 mm, 37% SL at notochord flexion, and then not changing significantly; head length 33% SL at 3.6 mm, attaining a maximum of 43% SL at 7.0 mm; head depth 91% head length at 3.6 mm, attaining a maximum of 122% at 5 mm.[1]

Dorsal profile of snout slightly concave at 3.6 mm, straight at about 5 mm, then convex. Marginal and lateral surface preopercular spines present with smooth sides. A low orbital crest with a weak spine present in early larvae, resorbed at metamorphosis. Supraoccipital

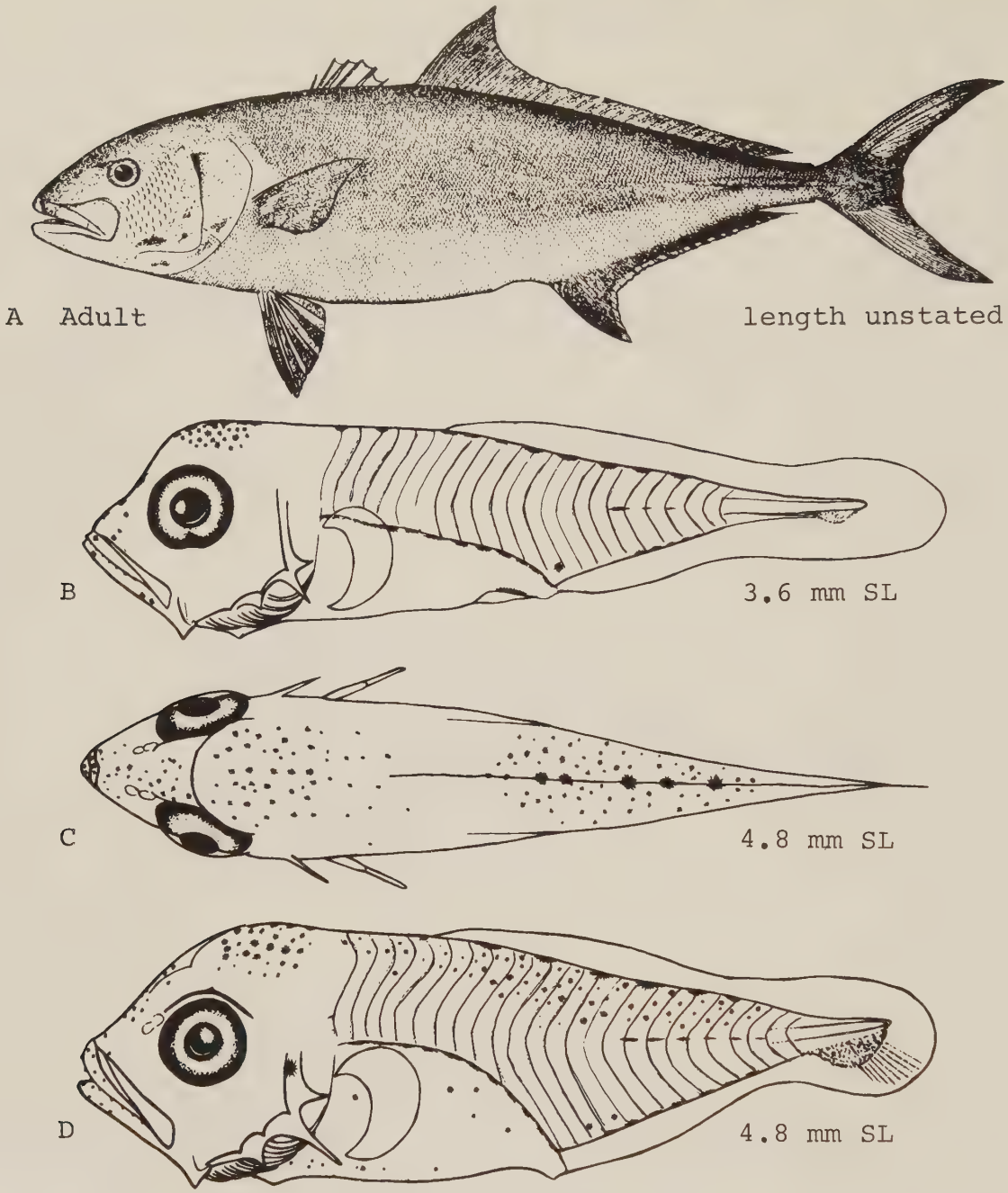

Fig. 57. *Seriola zonata,* Banded rudderfish. A. Adult, length unstated. B. Larva, 3.6 mm SL. C. Larva, 4.8 mm SL, dorsal view. D. Larva, 4.8 mm SL, lateral view. (*A, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 382. B-D, Aprieto, V. L., 1974: figs. 3A-C.*)

crest absent. Gut with a single loop to 10 mm. Hypaxial musculature developed at 6 mm and by 10 mm completely surrounds abdominal cavity except at anus.[1]

Pigmentation: At 3–7 mm 5–6 large melanophores on middorsal line at base of dorsal fin, apposed to myomeres, eventually becoming embedded in muscles and covered by more superficial melanophores. At 9 mm conspicuous melanophores along bases of dorsal and anal fins, on lateral midline and on peritoneum lining middorsal wall of abdominal cavity. In a freshly preserved 9 mm larva, dense concentrations of xanthophores on head, preopercle, and on back and upper sides of body; iridiophores profuse on sides of body below lateral midline. In older larvae, melanophores apparently actively expanding and contracting as most larvae have either

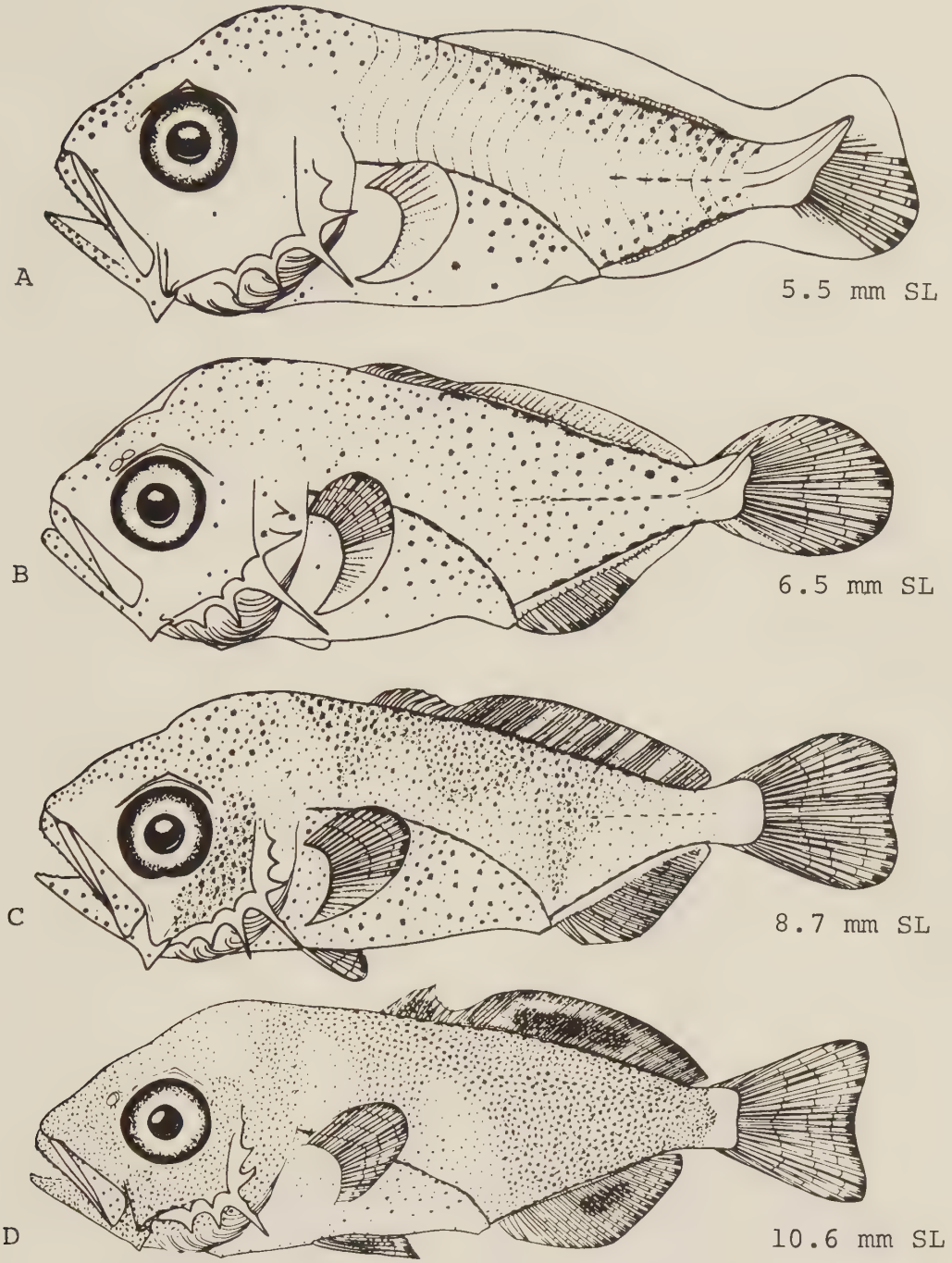

Fig. 58. *Seriola zonata,* Banded rudderfish. A. Larva, 5.5 mm SL. B. Larva, 6.5 mm SL. C. Larva, 8.7 mm SL. D. Larva, 10.6 mm SL. (*Aprieto, V. L., 1974: figs. 3 D-G.*)

Fig. 59. *Seriola zonata,* Banded rudderfish. A. Juvenile, 13.5 mm SL. B. Juvenile, 18.0 mm SL. C. Juvenile, ca. 50 mm SL. D. Juvenile, 179 mm TL. (*A-B, Aprieto, V. L., 1974: figs. H-I. C, Bigelow, H. B., and W. C. Schroeder, 1953: fig. 198. D, Ginsburg, I., 1952b: pl. 2, fig. b.*)

ontracted melanophores and are pale or expanded nelanophores and are dark; others with alternating atches of expanded and contracted melanophores orming false bands.[1]

UVENILES

ull complement of procurrent caudal rays present at bout 14 mm.[1]

ill rakers 15–23 to about 100 mm, 15–20 to about 200 nm, 12–16 to about 400 mm.[1]

ody depth never less than 30% SL in early juveniles; ead length 35% SL at 18 mm; head depth never less nan 89% head length in juvenile stage.[1]

t 15–17 mm a deep notch separates first and second orsal fins. Dorsal profile of snout convex. Scales formed t 20 mm along posterior end of lateral line in front of audal peduncle; subsequently scales along anterior por- on of lateral line ossify, followed by those of head and ides of body. Marginal and lateral surface preopercular pines present, gradually decreasing in size and becom- ng overgrown by expanding preopercle; marginal spine t angle longest with 1 or 2 denticles on dorsal side.[1]

igmentation: At 17 mm body definitely banded with a istinct nuchal bar [1] running straight from eye to dorsal rigin,[3,5] and 6 solid, regular bands,[1] the first directly ehind the head, the fifth a little in front of end of dor- al and anal fins, the sixth on caudal peduncle; the bands niformly pigmented, subequal in width to interspaces; [5] he third to fifth bars extending onto second dorsal fin nembrane, the fourth and fifth extending onto anal membrane (FHB); bands not becoming wavy or split with growth; a dark area at base of caudal may suggest a seventh band.[3] Bars and nuchal band solid black,[2,3] darker and more persistent than in other western Atlantic *Seriola* juveniles (FHB), chocolate brown in alcohol; [1] light brown or steely between bars with a faint golden or bronze stripe along sides. Lower part of body silvery.[2,3] Tips of caudal lobes white, a diagnostic character.[3] Banded pattern persists to about 220–260 mm.[5]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Trachinotus carolinus (Linnaeus), Florida pompano

ADULTS

D. V. or VI–I,[7,8,10] 22 [5,8,10]–27 [8,10] (usually 23–26 [10]); A. II–I, 20–23 [5,7,8,9,10] (usually 21–22 [4,10]); C. 9+8,[8,15] procurrent rays 8+7–8; [15] P. 17–19; [8,9] V. I, 5; [8] vertebrae 10+14; [15] gill rakers 3–7+7–12 (FHB); branchiostegals 7 (rarely 8 or 9); teeth present in jaws, on vomer and palatines (see Juveniles for detailed description), becoming reduced and overgrown with flesh and papillae in larger specimens.[8]

Depth 2–2.5,[7] head 3.2–4.1,[21] pectoral fin 3.9–4.8, pelvic fin 6.8–9.7 [7] in SL; snout 4.2 [21]–6.3,[7] eye 3.2–4.6 [21] in head.

Body moderately deep, compressed,[9] back moderately elevated; body outline without marked angles at origin of second dorsal and anal fins; [21] anus much nearer first anal spine than pelvic base; [9] head short and rather deep; snout short and blunt,[21] its anterior profile nearly vertical; [9] mouth moderate, slightly oblique, upper jaw in advance of lower; maxillary reaching to or slightly past middle of eye; [21] supramaxillary absent, a groove below upper margin of maxillary indicating a possible fusion with maxillary.[9] Dorsal spines low, disconnected (with growth), pungent, approximately subequal, the first often overgrown in large specimens; anterior two anal spines detached from remainder of fin; dorsal and anal fin lobes moderate, subequal, reaching to about middle of dorsal and anal fin bases [9] (above about 290 mm length, dorsal lobe equal to or less than head length [10]); pelvic fin reaching about half distance from its base to first anal spine. Scales very small, partly embedded; body almost completely scaled; predorsal area largely scaled to opposite preopercular margin; naked area on midback tapering backward to or almost to origin of spinous dorsal; head scaleless; caudal fin scaled, other fins scaleless. Anterior curve in lateral line very low; lateral line without scutes; accessory lateral line ending over posterior margin of head (often not discernible in large specimens).[9]

Pigmentation: Back and upper sides grayish-silvery blue or bluish green, sides silvery, ventral surfaces flecked with yellow; dorsal fin dusky or bluish; anal fin yellowish or light orange and caudal fin dusky or yellowish; [10] body areas frequently turning golden after death (FHB).

Readily separable from *T. falcatus* and *goodei* by higher number of dorsal and anal soft rays.[9]

Maximum length: Largest recorded about 612 mm.[10]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts and Bermuda to Brazil,[10] including Gulf of Mexico; rare in West Indies (FHB).

Area distribution: Chesapeake Bay at Solomons, Maryland and Cape Charles, Ocean View and Lynnhaven Roads, Virginia; [11] Worcester County, Maryland; [19] Atlantic, Cape May, Monmouth, and Ocean counties, New Jersey; [13] Delaware.[17]

Habitat and movements: Adults—abundant around inlets and along sandy beaches, often moving with the tide; [10] more characteristic of turbid than clear water.[20] Influenced greatly by temperature changes.[10] At least part of population appears to move northward along southeast U.S. in spring and summer; appear off New England states from July–September or October and presumably southward and nearer to warmer offshore waters in colder months; [5] taken in Chesapeake Bay from May–November, most abundant July–August; [11] most abundant in Tampa Bay in spring and summer; [3] taken year round in Gulf of Mexico, but less abundant in winter.[14] In Tampa Bay, taken in salinities from 32.1–35.6 ppt, not normally found in less than 32 ppt; in captivity can be adapted to fresh water.[4] Taken in temperatures from 17.0–31.7 C, mostly between 28.0–31.7 C; temperatures below 15 C generally unfavorable; may survive temperatures as low as 9.7 C for short periods; [3] in pond raised individuals critical minimum temperature about 10 C and maximum probably about 38 C.[4] Taken at least as deep as 40 m.[16]

Larvae—pelagic, offshore.[8]

Juveniles—most abundant on low energy (gently sloping) beaches on falling tides.[2] Developing juveniles move inshore and northward along the southeastern U.S. from May to December,[10] some reaching as far north as New York by September or October, but the majority which arrived in the surf zone in northern Florida remain there to about 120 mm SL (arrive at about 10 mm SL), when they move southward in response to colder temperatures.[2] Appear at 15–30 mm on St. Johns County, Florida beaches in early April and remain to about mid-November.[4] First appear on Georgia beaches at 11–20 mm in late April–May when temperature rises to about 19 C and leave in late October–December when temperature cools to about that.[8] Arrive at about 10 mm on Louisiana beaches in several consecutive waves: mid-April, mid-May, mid- and late June, early July, late August and early September; remain 2 1/2 to 3 months, moving to deeper water at about 110–120 mm TL.[6] Absent from Gulf of Mexico beaches from January–May; most abundant July–September; move to slightly deeper water in winter.[14] Common in lower Chesapeake Bay from late summer to fall.[11] Taken in salinities 10 [12]–36.7 ppt [14] but most at 20 ppt or higher; [12] in Laguna Madre, Texas taken in 45–50 ppt.[18] Taken from 10–34.9 C; [12] in captivity, stopped feeding at about 13 C.[1]

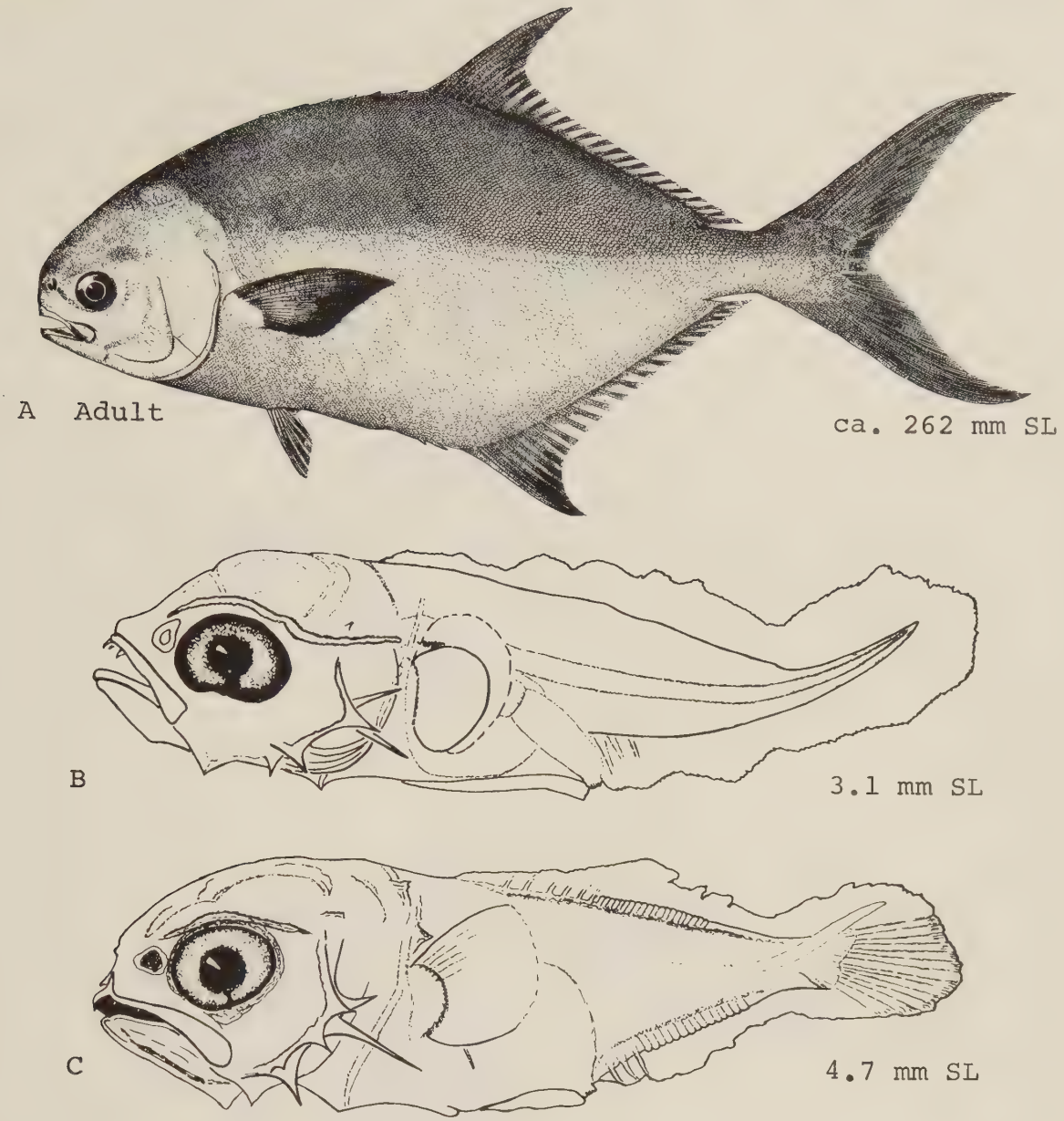

Fig. 60. *Trachinotus carolinus,* Florida pompano. A. Adult, ca. 262 mm SL. B. Larva (putative), 3.1 mm SL. C. Larva (putative), 4.7 mm SL. (*A, Goode, G. B., 1884: pl. 104. B, C, Fields, H. M., 1962: figs. 1, 3.*)

PAWNING

ocation: Probably occurs offshore.[3,5,8,10]

eason: Probably over an extended period;[1,3] off south- ast U.S. probably extends at least from March[10] (pos- bly February[5]) and continues through September;[10,25] pawning progresses northward,[2,5] possibly to North arolina by May or June;[2] greatest activity probably in ring (April–June;[3]) may occur throughout year in Gulf Mexico and Caribbean Sea.[5]

ecundity: Average female has 600,000–800,000 eggs;[1] 0,000 eggs in 356 mm FL ripe female.[3]

EGGS

Unfertilized: Symmetrical,[1] average diameter .7 mm;[1,3] surface smooth;[3] yolk large;[1,3] perivitelline space narrow (about 10–15% egg volume;[3]) 1 oil droplet.[1]

YOLK-SAC LARVAE

No information.

LARVAE

No information.

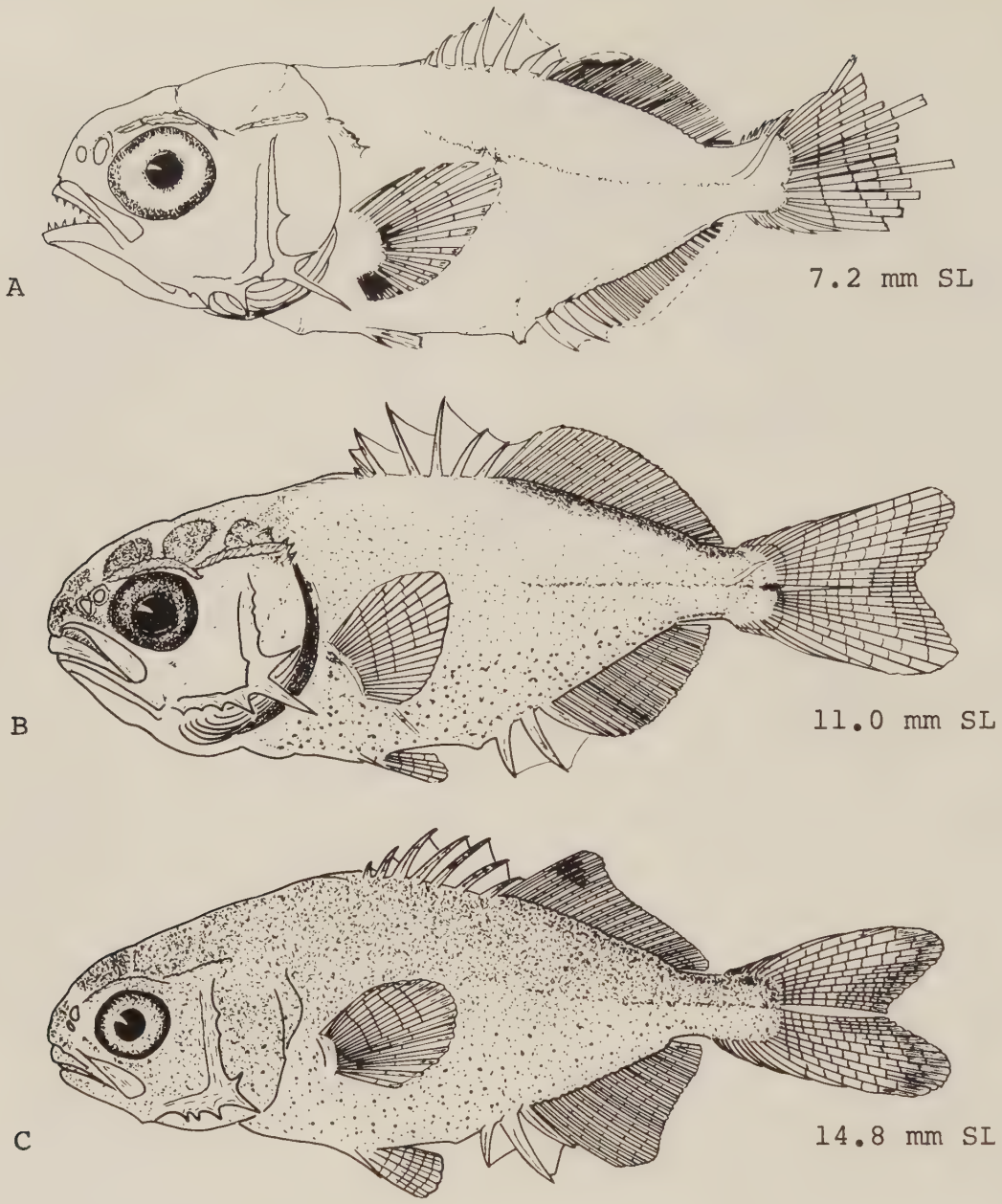

Fig. 61. *Trachinotus carolinus,* Florida pompano. A. Juvenile, 7.2 mm SL. B. Juvenile, 11.0 mm SL. C. Juvenile, 14.8 mm SL. (*A-C, Fields, H. M., 1962: figs. 4–6.*)

JUVENILES

About 7.0 mm and larger.

At 7.0 mm dorsal spines prominent and soft rays evident, all but 6 soft rays segmented, none branched; by 10 mm all soft rays segmented; at 18–20 mm branching occurs in all but first soft ray which branches at about 40 mm. At 7.0 mm anal spines prominent and soft rays evident, all but 5 soft rays segmented; at 10–11 all soft rays segmented; at about 17 mm branching of all but first soft ray has begun and is complete by about 21 mm; at about 27 mm first soft ray branches. At 7.2 mm all principal rays present and segmented, none branched; at about 10 mm the 2 median caudal rays branched; by about 11 mm 5 or 6 rays in upper lobe and about 5 in lower lobe branched; at 15–20 mm branching complete. At about 7.0 mm all but 4 pectoral soft rays segmented; at about 11 mm all soft rays segmented and branching has begun; at about 21 mm branching complete. Before 10–12 mm all pelvic soft rays segmented, none branched; between 12–16 mm various states of branching apparent; by about 16 mm branching complete. Below 11 mm

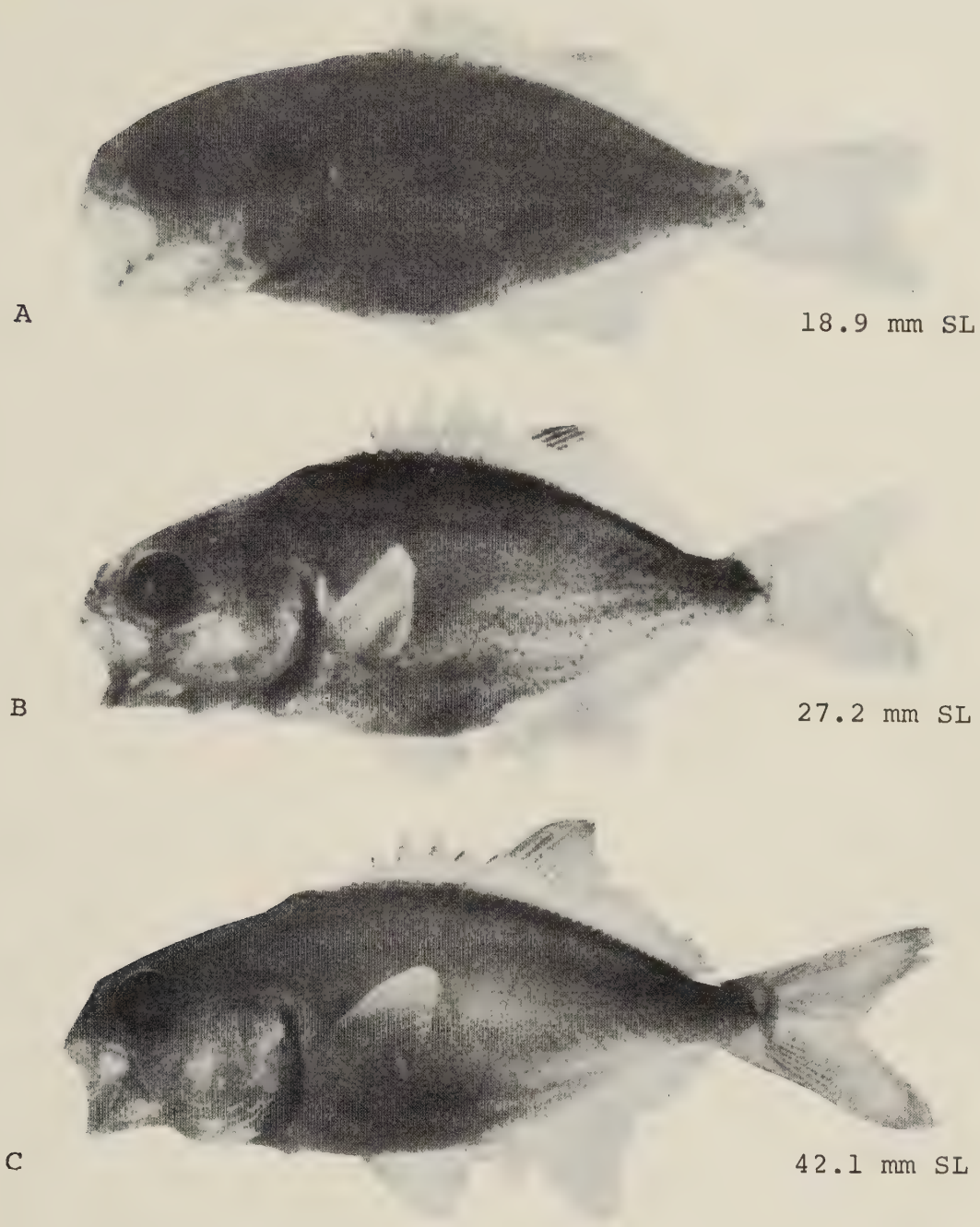

Fig. 62. *Trachinotus carolinus,* Florida pompano. A. Juvenile, 18.9 mm SL. B. Juvenile, 27.2 mm SL. C. Juvenile, 42.1 mm SL. (*A-C, Fields, H. M., 1962: fig. 7.*)

nterior distal margin of soft dorsal fin rounded, no lobe ident; at about 11 mm fin margin becomes angulated tips of soft rays 2–4 or 5 and forms distinct lobe, its lative length developing as follows: 10–20 mm, about % SL; 40–50 mm, about 22–25% SL; 50 to over 200 mm, –29% SL; 230–260 mm, 27–30% SL; over 260 mm about % SL. Anal fin lobe also first evident at about 11 mm, relative length developing as follows: 10–20 mm, 18–% SL; 60 mm 22–25% SL; 60–280 mm, 23–26% SL; over 280 mm, 21–24% SL. At 10–30 mm, gill rakers on lower limb 10–12; 50–80 mm, 9–11; over 80 mm, 6–10. Above 10 mm, 4–6 gill rakers on upper limb. At 7.2 mm preopercular margin with 3 large spines at angle (primary margin spines), plus 2 secondary spines on lower limb and 1 secondary spine on upper limb, and preopercular face with 1 small spine; at 11.0 mm marginal angle spines well developed, 3 spines on lower limb margin, 4 on upper limb margin, and 2 small spines on face; at

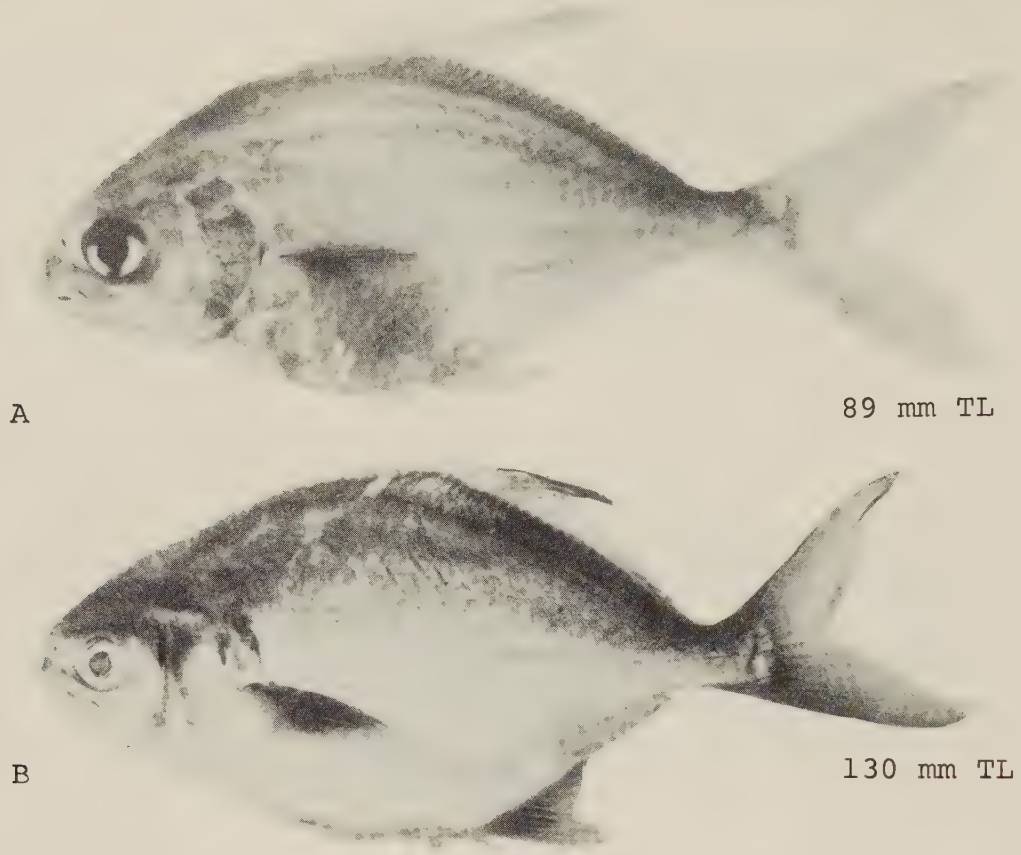

Fig. 63. *Trachinotus carolinus,* Florida pompano. A. Juvenile, 89 mm TL. B. Juvenile, 130 mm TL. (*Ginsburg, I., 1952b: pl. 4, figs. c-d.*)

12–13 mm margin spines reach maximum number, face spines lost; at 18–20 mm all but primary margin spines assimilated; at 24 mm upper and lower primary margin spines absent; at 33 mm last primary margin spine lost (sometimes evident to 45 mm).[8]

In specimens 20–60 mm teeth as follows: Teeth on premaxillaries and dentaries small, slender, conical, recurved; an irregular double row of strongly recurved teeth runs most of length of inner edge of premaxillaries; an irregular row of slightly larger teeth (8–10) on outer edge of each dentary for approximately half its length from symphysis, and 2–3 teeth located on each side, immediately behind row adjacent to symphysis. An irregular double row of smaller, strongly recurved teeth along inner edge of dentary for most of its length; area between single row and double rows covered with papillae; 3–5 teeth on vomer and a single row of about 5 slender teeth on each palatine. Teeth present in premaxillaries, dentaries, and on vomer, and palatines below 20 mm. Above 20 mm, vomerine and palatine teeth become overgrown in some, but still evident in some to 150 mm; at 150 mm all but dentary teeth disappear; by about 170 mm dentary teeth not evident.[8]

Pigmentation: Freshly killed 20–40 mm specimens in formalin showed following coloration: Chin, branchiostegal region, and ventral surface of body anterior to pelvic base white; belly and lower sides of body from pectorals to caudal base silvery white, flecked with plumbeous chromatophores; dorsal surface and upper sides of head and body metallic blue green; spinous dorsal with hyaline interspinous membranes; spines dusky, especially along leading edges; anterior part of soft dorsal virtually black, due to concentration of melanophores between first 6–7 soft rays; dorsal lobe dusky to tip; remainder of soft dorsal hyaline along distal margin and proximal third of fin, the base and area between hyaline parts lightly dusky; interspinous membranes and basal portion of soft anal fin hyaline; anal spines, leading edge of soft anal, and distal margin distinctly yellow[8] (tip of anal lobe cinnamon in some[4,5]); dusky lines formed by scattered melanophores between first 3–4 pectoral soft rays; remainder of pectoral fin yellow along proximal half and hyaline toward tip; pelvic fins bright yellow white; lobes of caudal fin bright yellow, flecked with melanophores, causing outer principal rays to appear dusky, pigmentation diminishing toward inner rays; dorsal procurrent rays dusky, ventral

es hyaline; eye with black pupil and silvery iris with ghtly dusky patch above and below pupil. Live captive ecimens between 15–30 mm showed limited ability to ange color from silvery to dusky, with an intermediate eppered" stage. Specimens between 30–50 mm gen- ally showed very little duskiness on body and fins, cept for leading edge and lobe of dorsal fin.[8]

ROWTH

aily growth rates range from .5 mm (a shift in the odes of surf-zone fry in the St. Augustine area from 33 53 mm FL) to 1.3 mm (mean size increase in tank- ared specimens from 56 to 116 mm FL).[2] Most rapid erage monthly growth rate estimates in cultures 30 mm d 27 g during a 6 month period from June–December; eatest average monthly weight gain 86 g in November; December largest specimen in this study weighed over 0 g; length-weight curve similar to wild stock, so can nceivably reach about 255–356 mm and 454–567 g in out one year.[1] Other average monthly growth rate timates in culture 21 mm[5] and 24 mm.[4] On basis of tal catch records in Tampa Bay area, average monthly owth estimate about 22 mm.[3] At Grand Isle, Louisi- a, natural average monthly growth rate estimate 36 m, range 27–42 mm; greater value here probably a sult of richer coastal waters.[6]

GE AND SIZE AT MATURITY

ild fish probably first spawn in second year,[1,4] but in culture may be possible to spawn them in less than 2 years. Ripe fish taken at Tampa Bay were 275–380 mm TL and weighed 456–1,140 g.[1]

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Trachinotus falcatus (Linnaeus), Permit

ADULTS

D. VI–I, 17–21; A. II–I, 16–19; [1,3,4] C. 9+8,[1,16] procurrent rays 7+8; [16] P. 17 [8]–20; [1,6,8] V. I, 5; [1] lateral line scales about 135; [8] vertebrae 10+14; [16] gill rakers 3–9+8–15 (FHB) (fewer with age [8]); branchiostegals 6 to 8 usually 8; teeth present in jaws, on vomer, palatines and tongue (see Juveniles for detailed description), becoming reduced and overgrown with flesh and papillae in larger specimens.[1]

Head 2.7–3.7 in SL; [18] depth 1.3–2.3 in SL, the larger adults more elongate; [8] snout 3.6–5.0, eye 2.8–3.1 in head.[18]

Body more or less ovate, strongly compressed; back elevated; [18] anus much nearer first anal spine than pelvic base; [6] snout short and blunt, its anterior profile nearly vertical; profile from snout to second dorsal moderately convex; dorsal and ventral outlines forming a marked angle at origin of second dorsal and anal fins; head short and deep; mouth small, slightly oblique, upper jaw in advance of lower; maxillary scarcely reaching middle of eye; [18] supramaxillary absent, a groove below upper margin of maxillary indicating a possible fusion with maxillary.[6] Dorsal and anal spines similar to *T. carolinus;* dorsal fin lobe when depressed, reaching approximately to a vertical through caudal base in a few, usually to end of dorsal base at about 150–250 mm TL, and becoming progressively shorter at larger sizes (FHB); anal fin lobe considerably shorter than dorsal. Scales and lateral line as in *T. carolinus.*[6]

Pigmentation: Back usually bluish to grayish [3,9] or iridescent blue to blue green,[6] silvery below; [3,6,9] sometimes pale yellow below level of pectoral fin; a broad patch of orange yellow on abdomen in front of anal fin,[8] may be reduced to pale gold (FDM); dorsal fin bluish or black along anterior margin and lobe; [3,9] anterior margin and lobe of anal fin and pelvic fin often orange; [3,9] pectoral fin blackish; [8] caudal dusky; [3,9] no cross bands or other distinctive marks; [6] very large specimens may be almost entirely silvery, with a greenish blue tinge, and all fins dark or dusky.[3]

Size: Largest recorded 1092 mm.[9]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts and Bermuda to Brazil,[3] including the Gulf of Mexico; [9] common in West Indies (FHB).

Area distribution: Chesapeake Bay at St. Mary's County, Maryland [14] and Cape Charles, Lynnhaven Roads and Ocean View, Virginia; [7] Worcester County, Maryland; [14] Metomkin Bay and Cobb Island, Virginia; [12] Atlantic, Ventnor, and Cape May counties, New Jersey; [17] Delaware River estuary.[15]

Habitat and movements: Adults—occur on sand flats and reefs to at least 30 m; also seen over mud bottoms; [8] may occur in surf, but also taken at edge of Florida Current; [3] tend to be solitary.[3] Appear to tolerate wider salinity range than *carolinus* in the wild; taken in Tampa Bay area at salinities from 23.0–35.6 ppt, but 85% taken above 31 ppt. In mariculture studies have survived temperatures as low as 9.7 C for short periods, but generally temperatures below 15 C unfavorable.[2]

Larvae—pelagic, offshore; [1,3,11] smallest specimens about 6–12 mm taken in Florida Current and Gulf Stream.[3]

Juveniles—apparently move inshore at about 12–50 mm, where they are usually found in small schools over sandy beaches,[3] larger juveniles occasionally found on periphery of grass beds and around mangroves (FDM). Recruitment occurs from May–October on Georgia beaches; [11] first arrive in late May or early June at a size range of 18–44 mm when water warms to about 27 C, and remain on beaches until water cools to about 19.5 C; between early September and mid-October, a major influx of 12–40 mm specimens.[1] Recruitment occurs year round on south Florida beaches,[1,11] generally at much smaller sizes than on Georgia beaches; specimens less than 12 mm taken from January–September, probably a result of close proximity to Gulf Stream.[1] Taken in Tampa Bay area from July–December,[10] most abundant in July; two-thirds of catches made from June–September; specimens as small as 15 mm taken from June–October.[2] Sometimes common July–October at Woods Hole; rather common at New York August–October.[15] Taken in salinities from .8 [2]–43.9 ppt.[13] Taken at temperatures from 16.4 [12]–34.0 C.[13]

SPAWNING

Probably occurs offshore,[1,2,11] apparently in or in close association with Gulf Stream [1] and Florida Current.[3] A 12.7 mm specimen taken off Cape Fear in January supports the possibility of some winter spawning.[11] May extend from December–September,[3] with main spawning occurring in spring from April to June [2] (particularly concentrated around May [3]), followed by lesser spawnings in summer and early fall (July–October).[2]

EGGS

No information.

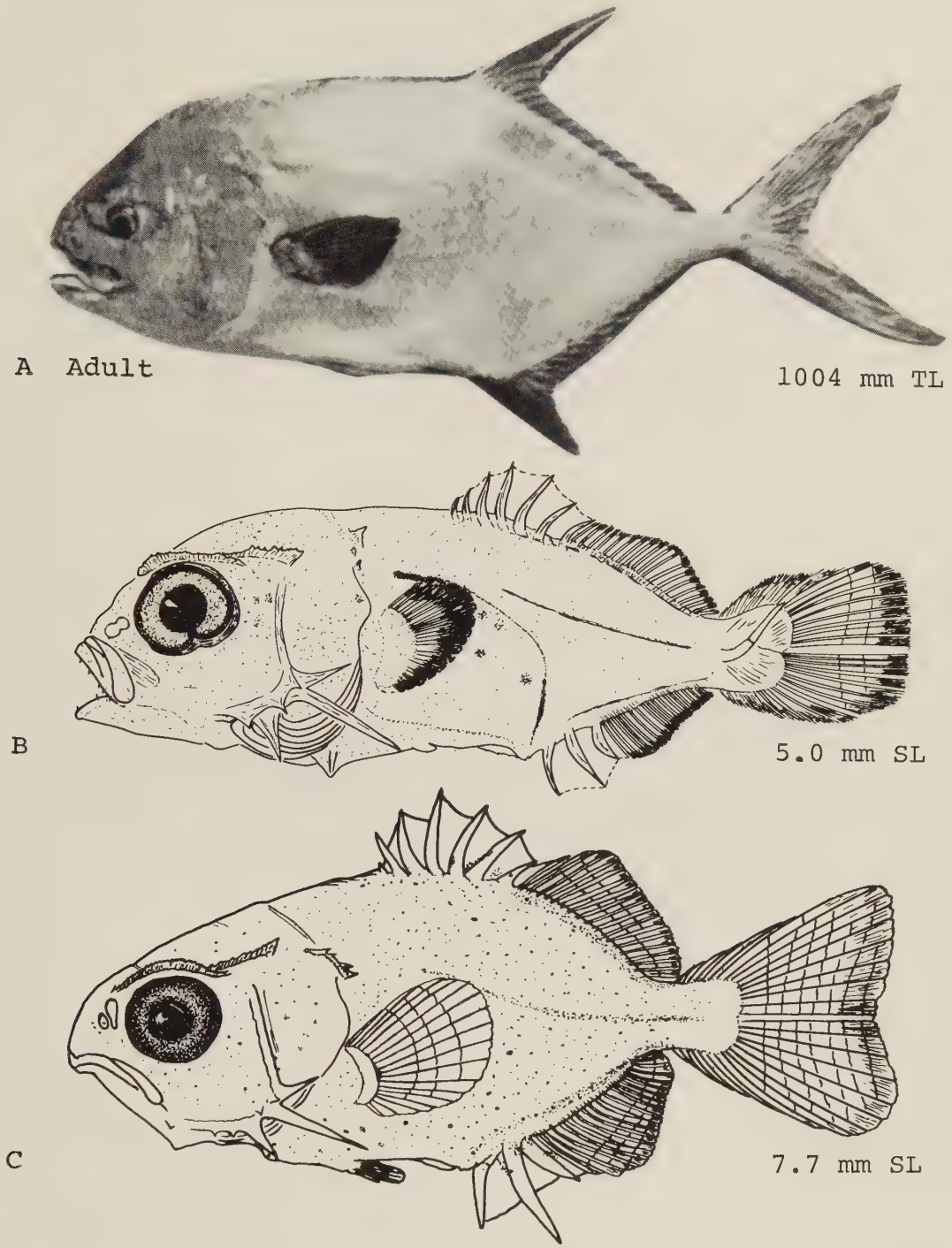

Fig. 64. *Trachinotus falcatus*, Permit. A. Adult, 1004 mm TL. B. Larva, 5.0 mm SL. C. Juvenile, 7.7 mm SL. (*A, Randall, J. E., 1968: fig. 132, © T.F.H. Publications. Used with permission of author and publishers. B, C, Fields, H. M., 1962: figs. 8–9.*)

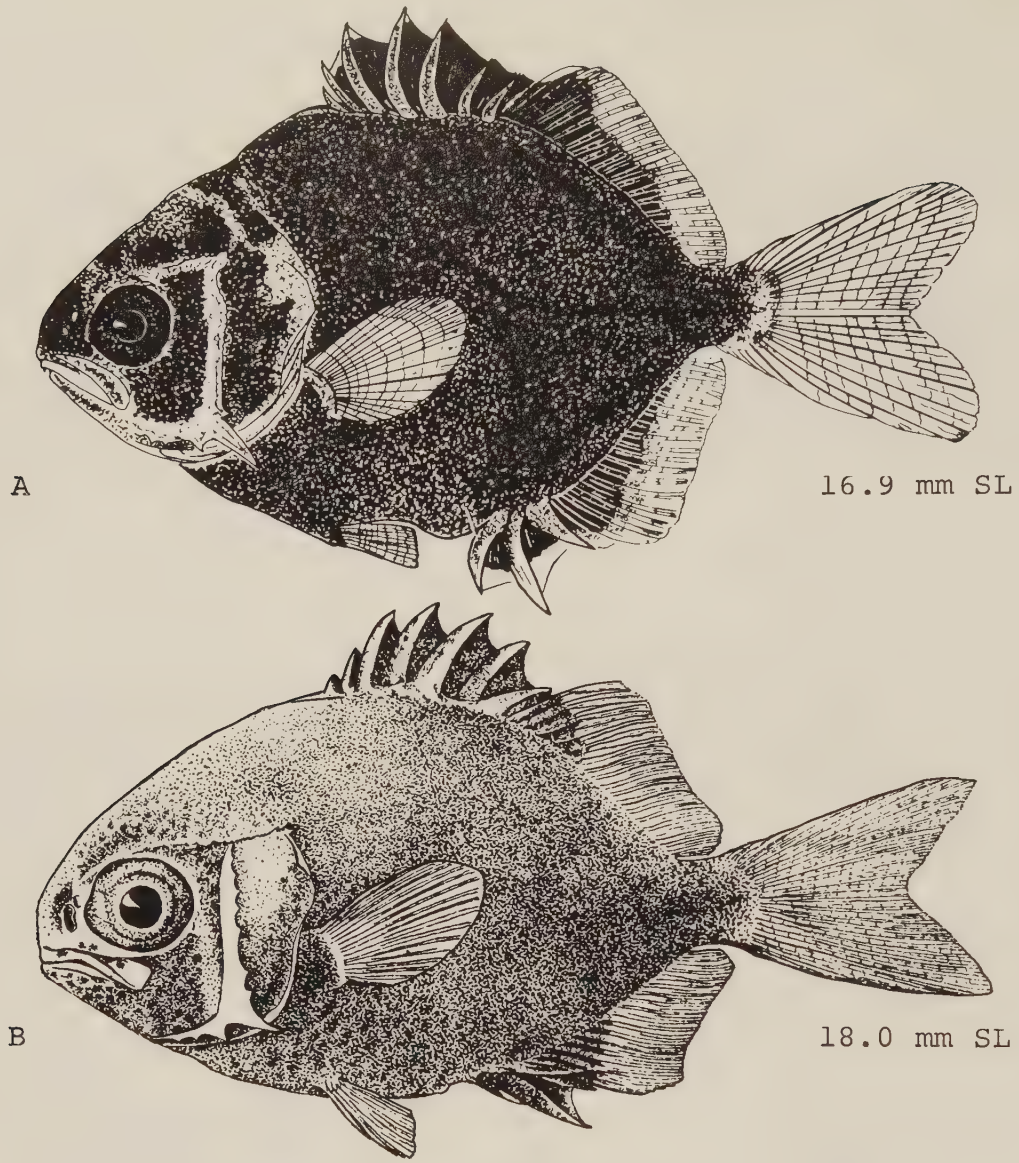

Fig. 65. *Trachinotus falcatus*, Permit. A. Juvenile, 16.9 mm SL. B. Juvenile, 18.0 mm SL. (*A, Fields, H. M., 1962: fig. 10. B, Hildebrand, S. F., and W. C. Schroeder, 1928: fig. 134.*)

YOLK-SAC LARVAE

No information.

LARVAE

To about 7.0 mm.

At 5.0 mm dorsal and anal spines prominent, soft rays evident but not segmented. At 5.0 mm pectoral rays evident, not segmented. At 5.0 mm pelvic fins present as buds; at about 6.5 mm pelvic fins small, flattened, flipper-like structures without spines or soft rays. At 5.0 mm preopercle with 3 marginal spines at angle (primary margin spines), a secondary margin spine on lower limb and 3 spines on lateral face. At 5.0 mm teeth present in jaws, on vomer and palatines, none on tongue.[1]

JUVENILES

About 7.0 mm and larger.

At 6.5–9.0 mm all but 1–3 dorsal soft rays segmented; at about 12.0 mm branching begins; at 17 mm all soft rays except first branched; at 20–24 mm branching complete. By 6.5–8.0 mm all but 1–5 anal soft rays segmented; by 9 mm all soft rays segmented; at 13 mm branching begins; at 18–19 mm branching complete. At 7.2 mm full complement of principal caudal rays present and segmented, none branched; at about 10 mm 2 median rays

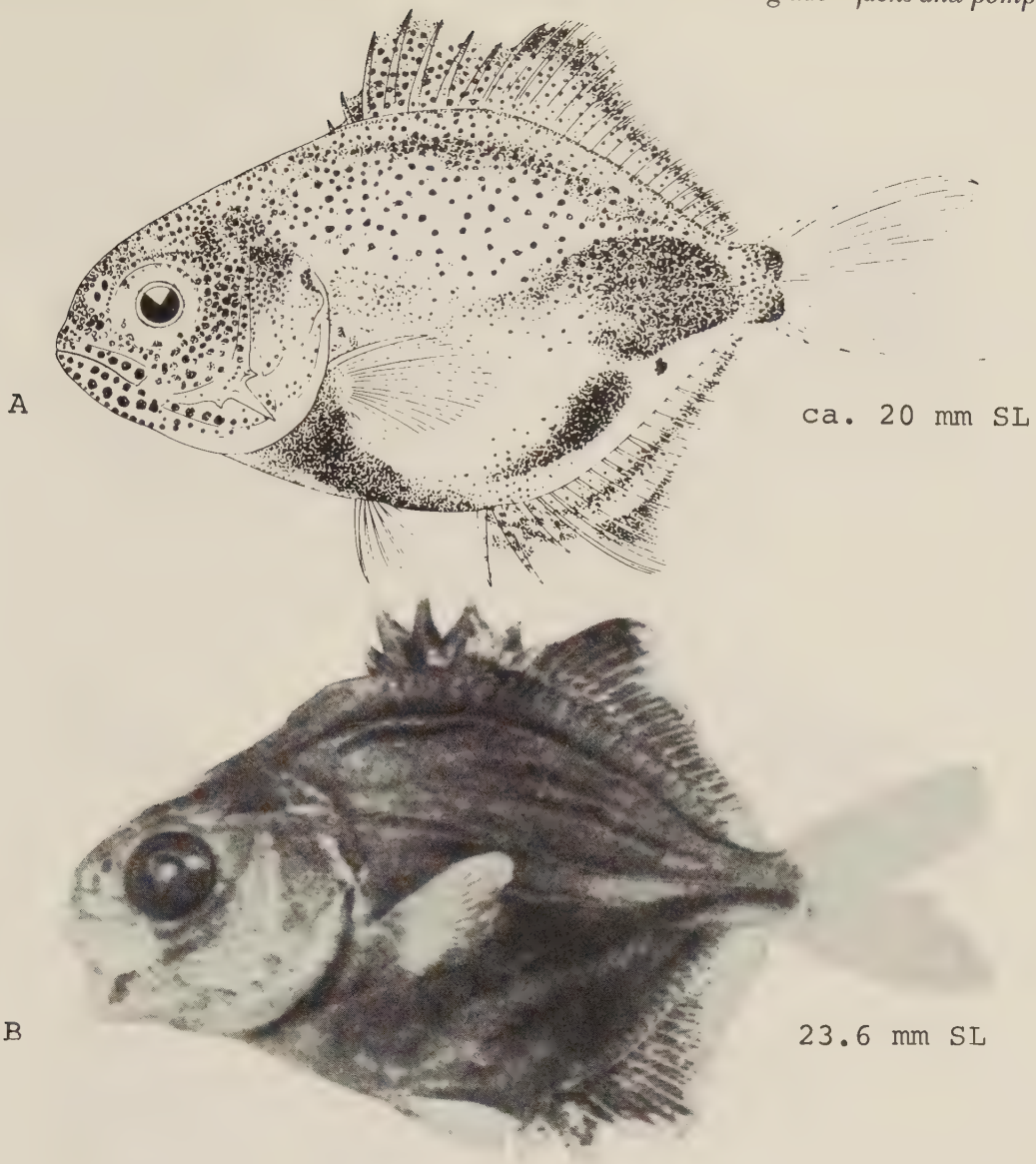

Fig. 66. *Trachinotus falcatus,* Permit. A. Juvenile, ca. 20 mm SL. B. Juvenile, 23.6 mm SL. (*A, Fowler, H. W., 1936: fig. 322. B, Fields, H. M., 1962: fig. 11, upper.*)

nched; at about 11 mm 5–6 rays in upper lobe and ut 5 in lower lobe branched; at 15–20 mm branching plete. By about 7 mm all but 4–5 pectoral soft rays mented; by 9–12 mm segmentation complete; at 14 branching begins; at 20 mm branching usually plete (complete in some by 17 mm and in some not 45 mm). At 7–7.5 mm pelvic spine and soft rays ent; by about 9.5 mm segmentation complete; at 2 mm branching begins; at 14–18 mm branching plete. Below 11 mm, anterior distal margin of soft al rounded, no lobe evident; at about 11 mm fin gin becomes angulated at tips of soft rays 2–4 or 5 ing a distinct lobe, its relative length developing as ws: 10–20 mm, 20% SL; 40–50 mm, 22–29% SL; 216.5 mm, 47% SL; continues to increase through all sizes examined. Anal fin lobe also first evident at about 11 mm, its relative length developing as follows: 10–20 mm, 18–22% SL; 60 mm, 24–26% SL; continues to increase through all sizes examined. At 10–40 mm gill rakers 3–8 + 12–14; at 40–100 mm 5–7 + 10–14; over 100 mm 3–7 + 8–13. At about 7 mm preopercle with 3 primary margin spines still well developed, 2 additional secondary margin spines on upper limb, 1 additional on lower limb, and the 3 lateral face spines receding; at 11 mm, 2 secondary spines on lower limb, about 5 on upper limb, 3 face spines relatively small; at 13–20 mm, 2–3 secondary spines on lower limb, 2 to many on upper limb, none on face; by 20–30 mm only the 3 primary

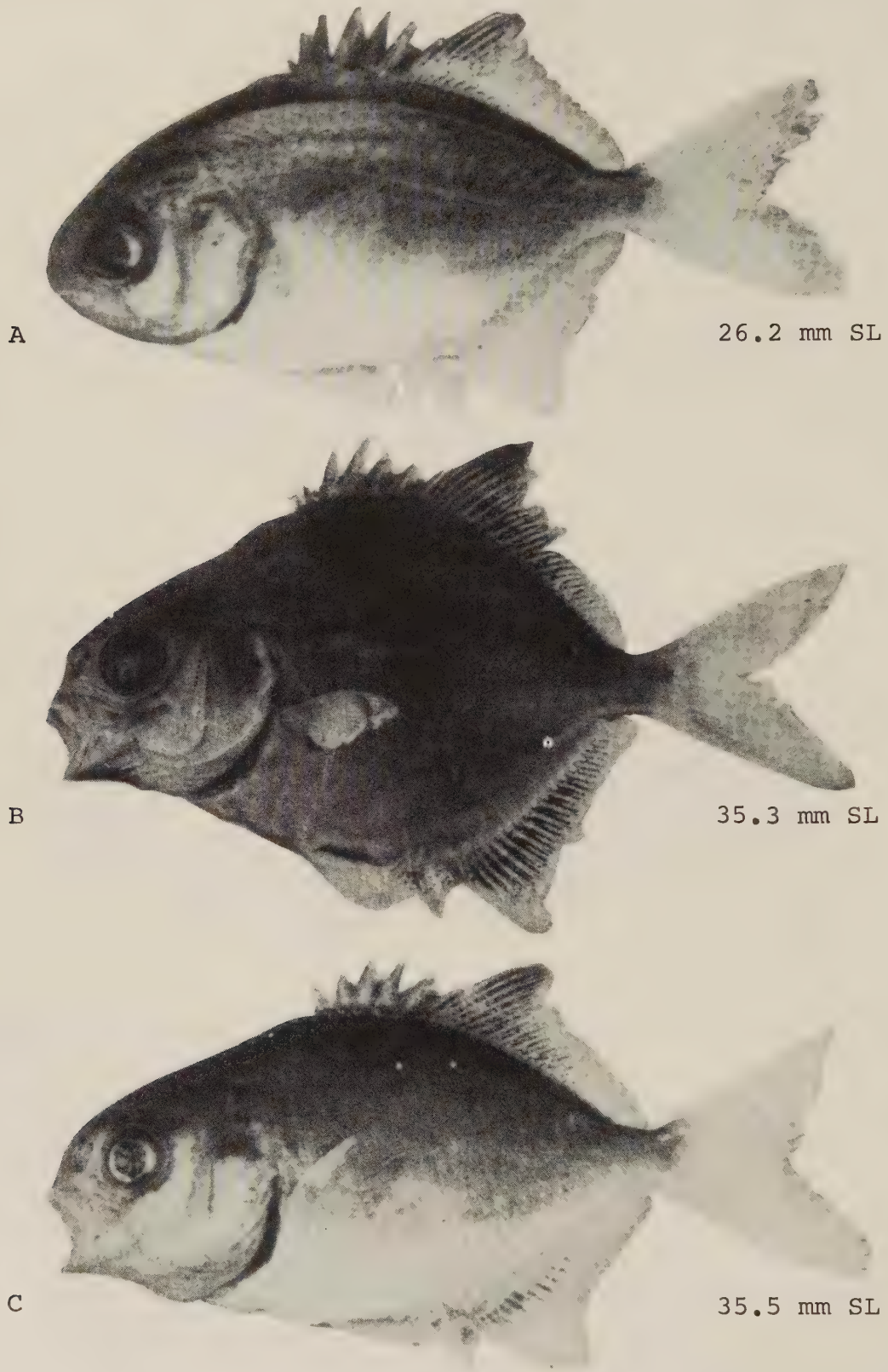

Fig. 67. *Trachinotus falcatus*, Permit. A. Juvenile, 26.2 mm SL. B. Juvenile, 35.3 mm SL. C. Juvenile, 35.5 mm SL. (*A-C, Fields, H. M., 1962: figs. 11 lower, 12.*)

Fig. 68. *Trachinotus falcatus*, Permit. A. Juvenile, 48.0 mm SL. B. Juvenile, 59.5 mm SL. (*A, Meek, S. E., and S. F. Hildebrand, 1925: pl. 33. B, Fields, H. M., 1962: fig. 13.*)

gin spines still evident; by 30–32 mm all spines nilated.[1]

n as in *T. carolinus* with following exceptions: be- n 10–80 mm, teeth also present on tongue; between 40 mm, some specimens without teeth evident on r, palatines, and tongue; between 140–190 mm teeth evident only on tongue and dentaries; at 216.5 mm no teeth evident.[1]

Pigmentation: Color variable. In general, small juveniles (i.e., beach-caught fry) may be almost entirely black, or largely silvery, or black and silvery with a dark red tinge, with the apparent ability to rapidly alternate these

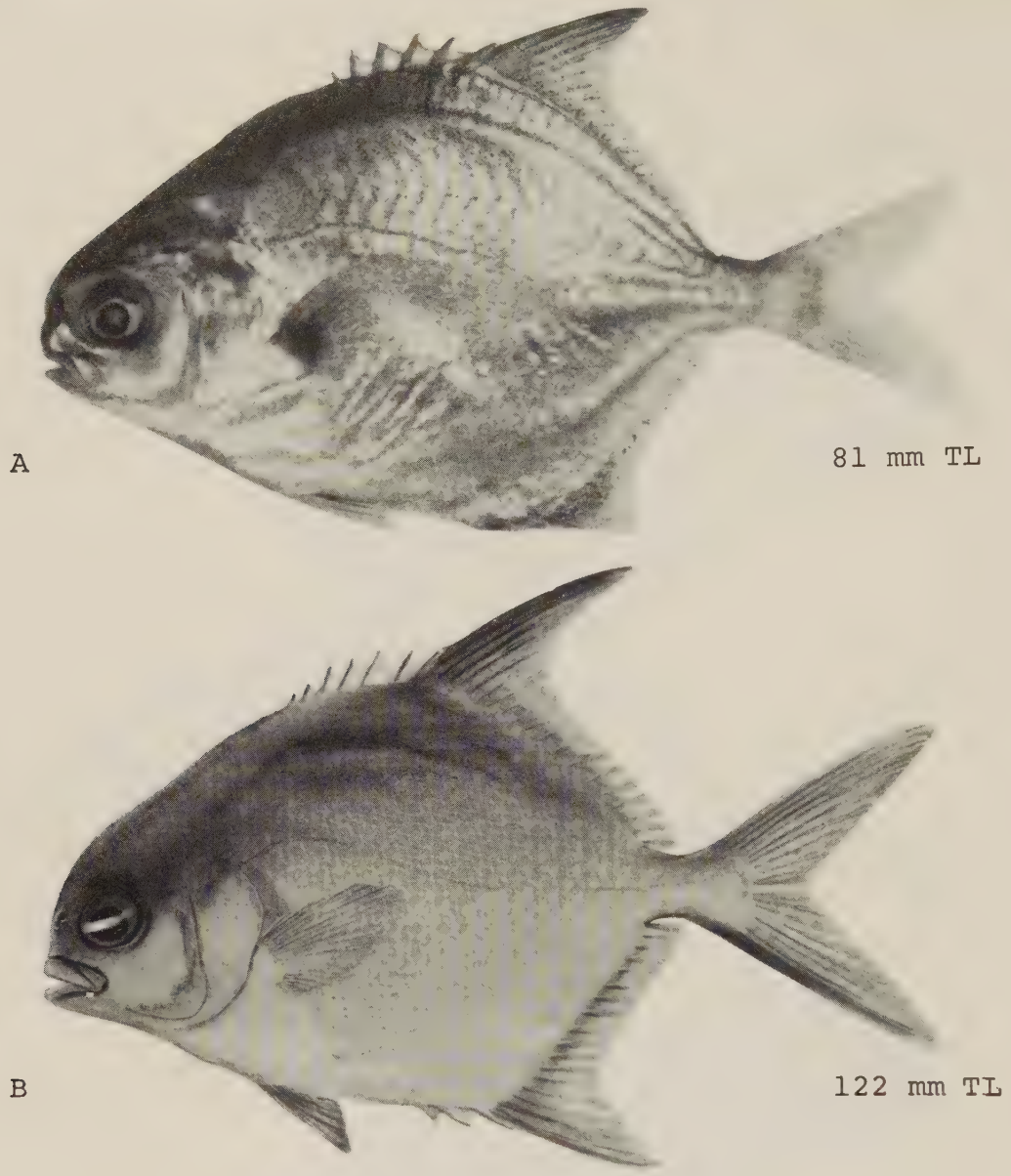

Fig. 69. *Trachinotus falcatus*, Permit. A. Juvenile, 81 mm TL. B. Juvenile, 122 mm TL. (*A, Ginsburg, I., 1952b: pl. 4, fig. b. B, Böhlke, J. E., and C. C. G. Chaplin, 1968: 338, © Academy of Natural Sciences of Philadelphia. Used with permission of authors and publishers.*)

colors.[3,9] More detailed color descriptions follow. At 9.8 mm a preserved specimen from Fort Pierce, Florida showed the following: body above midline and behind pectoral base brown; sides of abdomen with large dark melanophores; area behind abdomen and below midline with small scattered brown chromatophores and melanophores on flesh colored background; large dark melanophores along dorsal base, anal base and posterior part of midline, extending onto caudal peduncle, giving the effect of faint lines along these areas; spinous dorsal and spinous anal fin areas dark brown; other fins hyaline. A live 43 mm specimen from Haiti: entire body thickly covered with small brown spots, except for maxillary, premaxillary, and branchiostegal membrane; top of head brick red; spinous dorsal and anterior soft dorsal membrane black, diminishing posteriorly on soft dorsal; a few black dots on dorsal spines; membrane between anal spines and anterior soft rays black; other fins pale. Two live 15 mm specimens from Haiti: iridescent bronze throughout; iris and thickened web of dorsal and anal spines grenadine red; the web between these spines and the basal half of the dorsal and anal rays black. A live 45 mm specimen from Haiti: bluish silvery, with minute black punctulations over entire body except lower chin

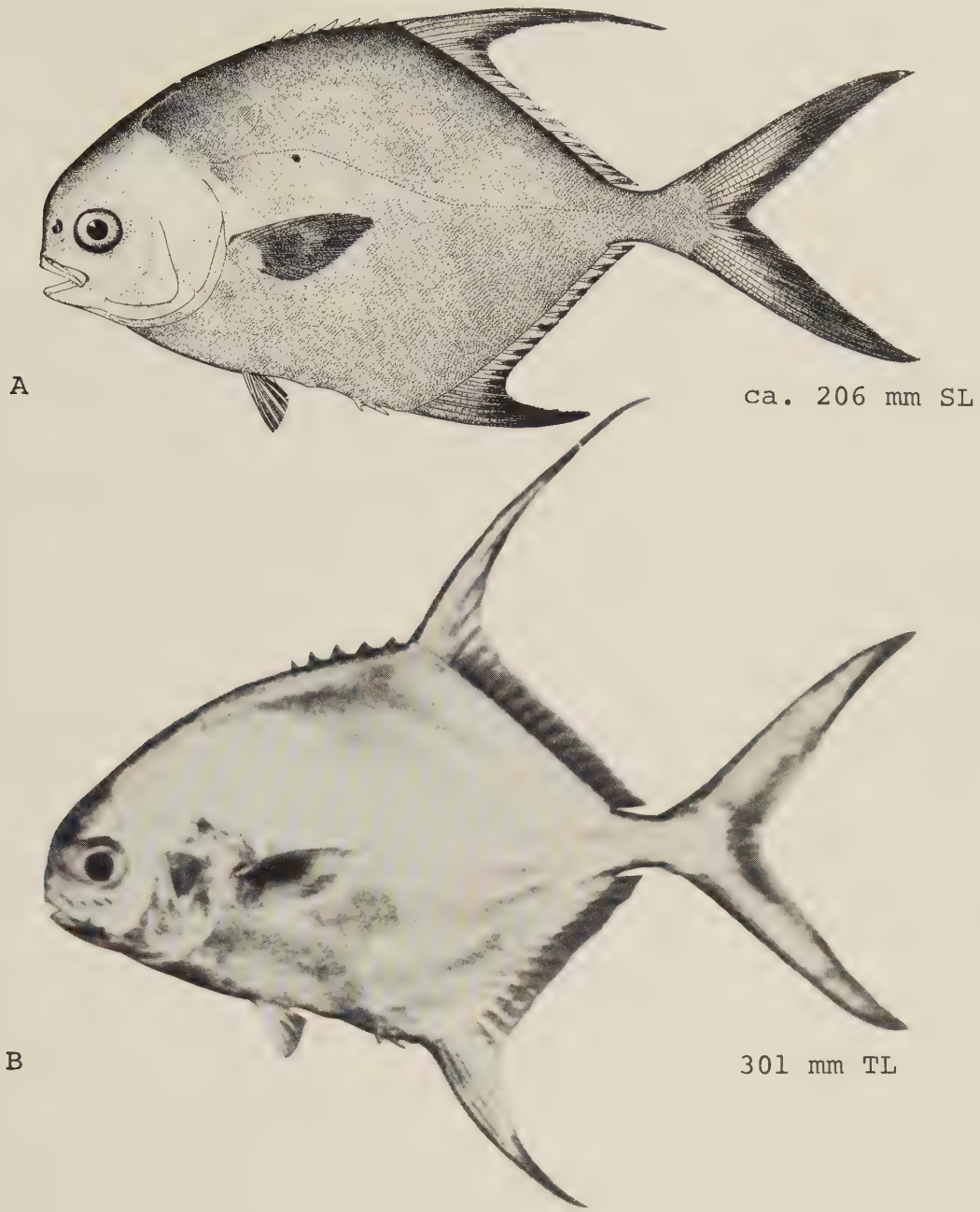

Fig. 70. *Trachinotus falcatus,* Permit. A. Juvenile, ca. 206 mm SL. B. Juvenile or young adult, 301 mm TL. (*A, Goode, G. B., 1884: pl. 105. B, Randall, J. E., 1968: fig. 131, © T.F.H. Publications, used with permission of author and publishers.*)

ıus, and area just anterior to pelvic fins; dorsal fin branes dusky; anal fin membranes dusky basally, duskiness decreasing posteriorly; pectoral fin clear; of pelvic fins, anal spines and tip of anal lobe ge red. Three fresh specimens, 59–61 mm (location ıpture not specified): chin, isthmus, opercle, area v eye and body below lateral line silvery white (in light orange on a white background shows on lower of preopercle, mandibular articulation, chest and anal region); body above lateral line and dorsal half of head light metallic; dorsal spines and membranes plumbeous; soft dorsal fin dusky, especially lobe; anal spines and lobe very bright orange; outer margin of soft anal fin hyaline, remainder dusky; pectoral fin dusky at base, hyaline elsewhere; pelvic fin with white background interspersed with very bright orange; caudal fin with orange yellow on most of lobes; outer rays dusky almost to tips, inner rays grading to hyaline. At 39.5 mm speci-

men similar except duskier, and orange more intense.[1] At about 200 mm SL, dorsal lobe dark black along leading edge and distal 1/3, becoming clear basally; anal fin lobe black on distal 1/3, orange on basal 2/3 (remainder clear); orange ventrally to include part of pelvic fin (FHB). Tests with live fish in aquaria showed that the silvery phase was usually retained until a fish was disturbed, at which time the posterior half of the body turned uniformly dark brown, and this color migrated anteriorly. Undisturbed color changes usually involved duskiness or blackness on areas of the body and the dorsal fin lobe.[1]

The bright orange or red anal fin lobe is useful in distinguishing this species from *T. carolinus*.[5]

GROWTH

Average natural monthly growth rate during first year estimated at 15–20 mm; [2] in Tampa Bay specimens ranged from 8.2–19.8 mm in June, increasing to 63.6–109.6 mm by November.[10]

AGE AND SIZE AT MATURITY

No information.

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Trachinotus goodei Jordan and Evermann, Palometa

LTS

I–I, 19–20; A. II–I, 16–18; [1,4,6] C. 9+8,[1,12] procur-ays 7–8+7; [12] P. 16 [1,5,6]–20 [1] (modally 17 [1,5]); V. I, ateral line scales about 107; [5] vertebrae 10+14; [12] akers 3–9+9–14 (FHB); branchiostegals 7 to 8, y 8; [1] teeth present in jaws, on vomer and pala- (see Juveniles for detailed description), none on e; teeth persistent with growth, but becoming re- l in extent on roof of mouth [6] (a 211 mm specimen d teeth on vomer); teeth in general becoming rown with skin and papillae with growth.[1]

3–3.9, depth 1.9–2.6, pectoral fin 4.5–5.5 in SL; 3.7–4.7, eye 3.0–4.1, maxillary 2.2–2.8 in head.[13]

more or less elongate, strongly compressed; back rately elevated; [13] anus much nearer first anal spine pelvic base; [6] head rather low, snout very blunt; e over snout very steep, only slightly convex from to origin of second dorsal; dorsal and ventral out- forming broad obtuse angles at origin of second l and anal fins; mouth rather small; upper jaw in ace of lower; maxillary reaching about middle of [3] supramaxillary absent, a groove below upper n of maxillary indicating a possible fusion with lary. Dorsal and anal spines similar to *T. caro-* [6] dorsal and anal fin lobes greatly elongated; dorsal may extend beyond fork of tail when depressed; [4] obe subequal to dorsal or shorter. Scales and lat- ine as in *T. carolinus*.[6]

entation: Dark silvery [4] or bluish silver above, shad- silver [5] or silvery golden [4] on sides; lower third of light golden yellow,[5] with a bright orange breast [4] t with a faint wash of gold (FDM); 4 dark narrow high on side of body; [4,5,6] first bar a little in front st dorsal spine; fourth bar nearly under middle of dorsal, more widely spaced and shorter than an- 3 bars, sometimes very short or absent in preserved mens; first 3 bars extending over greater part of ace between lateral line and midback, continuing short distance below lateral line; [6] a trace of a fifth ehind fourth,[4] or 5th may be distinct but only one-eighth as long as longest bar; bars faint in and very large preserved specimens; caudal ncle often with 1 or 2 dark spots at lateral line, ehind the other; [6] dorsal and anal fin lobes black or t black,[4,5,6] remainder of these fins dusky or pale bluish edges; caudal fin dusky or bluish [4] or black rsal and ventral margins through tips (FHB); pec- fins golden and bluish [4] or clear (FHB); pelvic hitish.[4]

ly distinguished from other *Trachinotus* species in rn Atlantic by the very prolonged dorsal and anal es, a body of medium depth, and the cross bars; [6] the narrow dark body bars and the dark falcate lobes of the dorsal, anal, and caudal fins create a striking effect.[4]

Maximum length: Largest recorded 355 mm, reported to reach 490 mm.[5]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts and Bermuda to Argentina,[5] including Gulf of Mexico; [6] rare along U.S. coast, main part of range further south [1,9] (juveniles common in southeast Florida in spring and summer); common in West Indies (FHB).

Area distribution: Chesapeake Bay.[7,8]

Habitat and movements: Adults—frequently observed in clear water along sandy shores.[5] Greatest movement recorded in tagging experiment 385 nautical miles in 66 days.[11] Taken off Texas at 35.7 ppt and 29 C.[10]

Larvae—no information.

Juveniles—on beaches in Georgia, August–November; [1] small juveniles only taken in summer and fall in Florida [9] and Texas.[10]

SPAWNING

Some evidence that occurs in late summer and fall in South Atlantic Bight,[9] but the capture of 20–60 mm juveniles in June supports a spring or early summer spawning (FHB).

EGGS

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

About 7 mm and larger.

At 7.8 mm all dorsal soft rays except first 1 and last 3 segmented; at 11.8 mm segmentation complete; at 19 mm branching has begun; at 23 mm all soft rays but first branched; at 28–35 mm all soft rays branched. At 7.8 mm all but first and last anal soft rays segmented; at 11.8 mm segmentation complete; at 19 mm branching

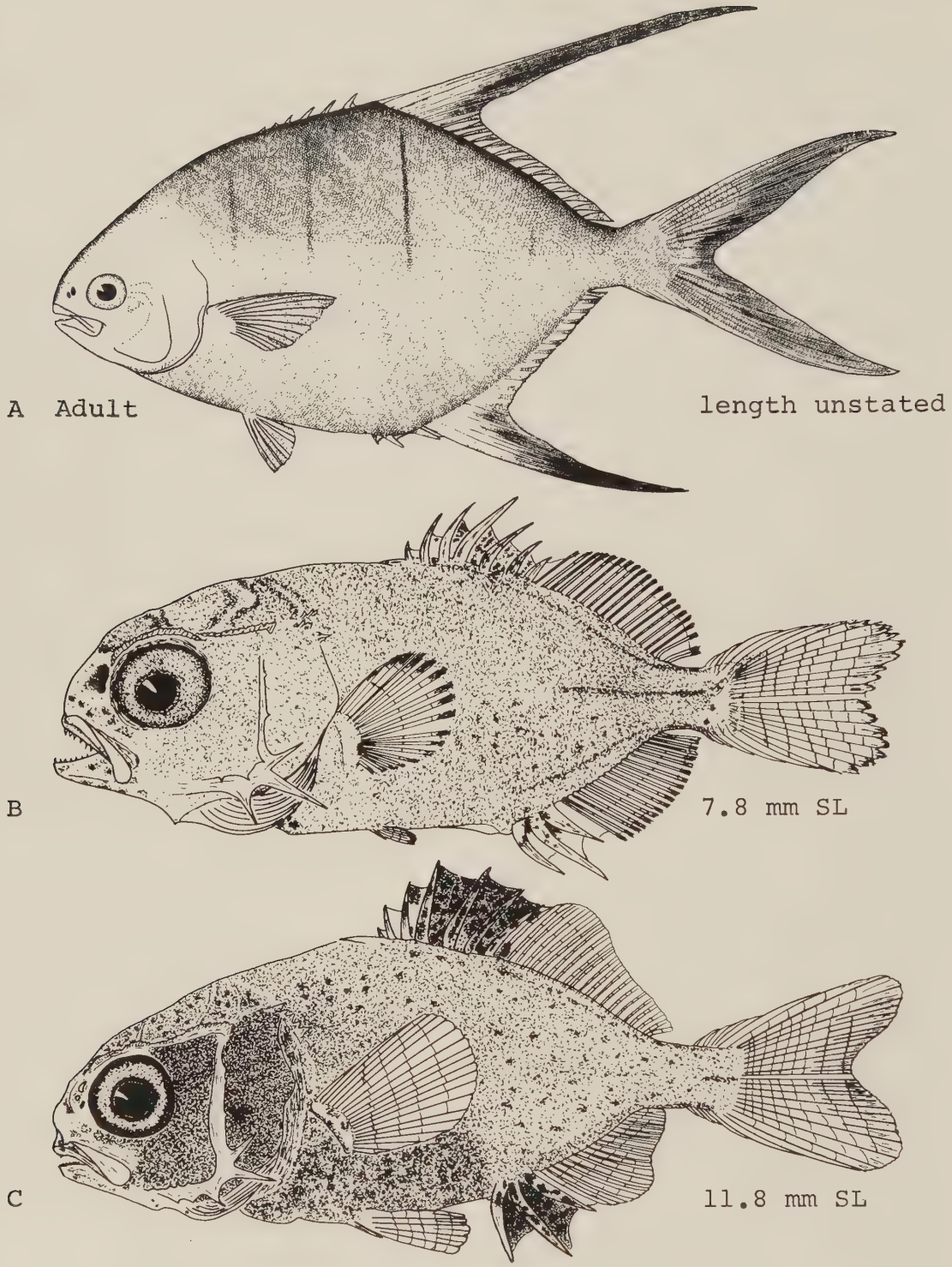

Fig. 71. *Trachinotus goodei*, Palometa. A. Adult, length unstated. B. Juvenile, 7.8 mm SL. C. Juvenile, 11.8 mm SL. (*A, Goode, G. B., 1884: pl. 106. B, C, Fields, H. M., 1962: figs. 14–15.*)

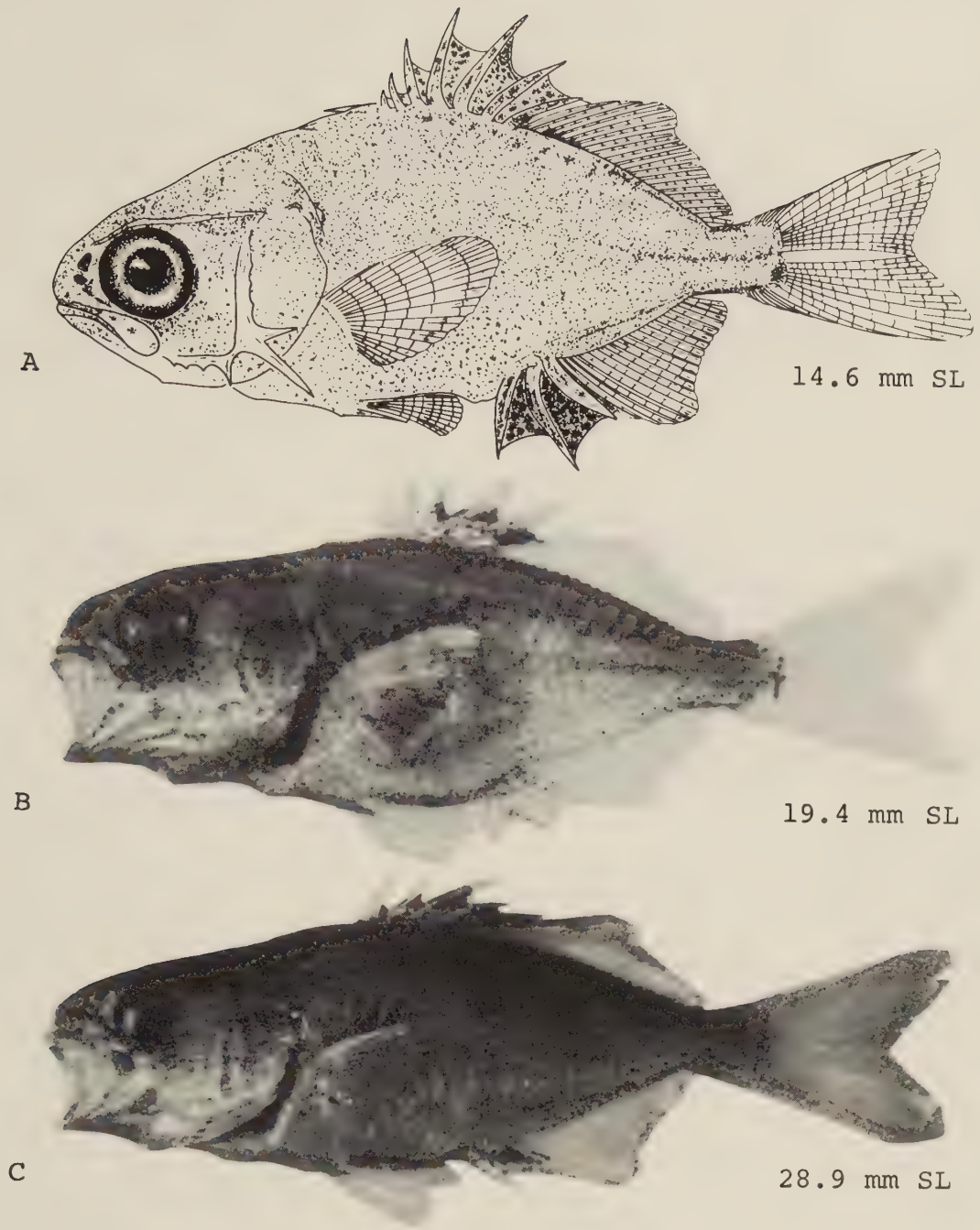

Fig. 72. *Trachinotus goodei,* Palometa. A. Juvenile, 14.6 mm SL. B. Juvenile, 19.4 mm SL. C. Juvenile, 28.9 mm SL. (*A-C, Fields, H. M., 1962: figs. 16, 17 upper, middle.*)

t begun; at 22 mm branching complete in some; rmost soft ray not branched in some until 28 mm. mm all principal caudal rays present and seg-l, none branched; at 11.8 mm 6 rays in upper lobe in lower lobe branched; at 14.6 mm 7 upper rays lower branched; by 15 mm branching complete. mm all pectoral soft rays segmented; at 16 mm ing has begun; at 19 mm all but 3–10 soft rays branched; at 35–48 mm branching complete. At 7.8 mm all pelvic soft rays branched; at 11.8 mm branching complete. Below 11 mm, anterior distal margin of soft dorsal rounded, no lobe evident; at about 11 mm fin margin becomes angulated at tips of soft rays 2–4 or 5 forming a distinct lobe, its relative length developing as follows: 10–20 mm, about 22% SL; 40–50 mm, 22–29% SL; 211 mm, 72% SL; continues to increase in all sizes

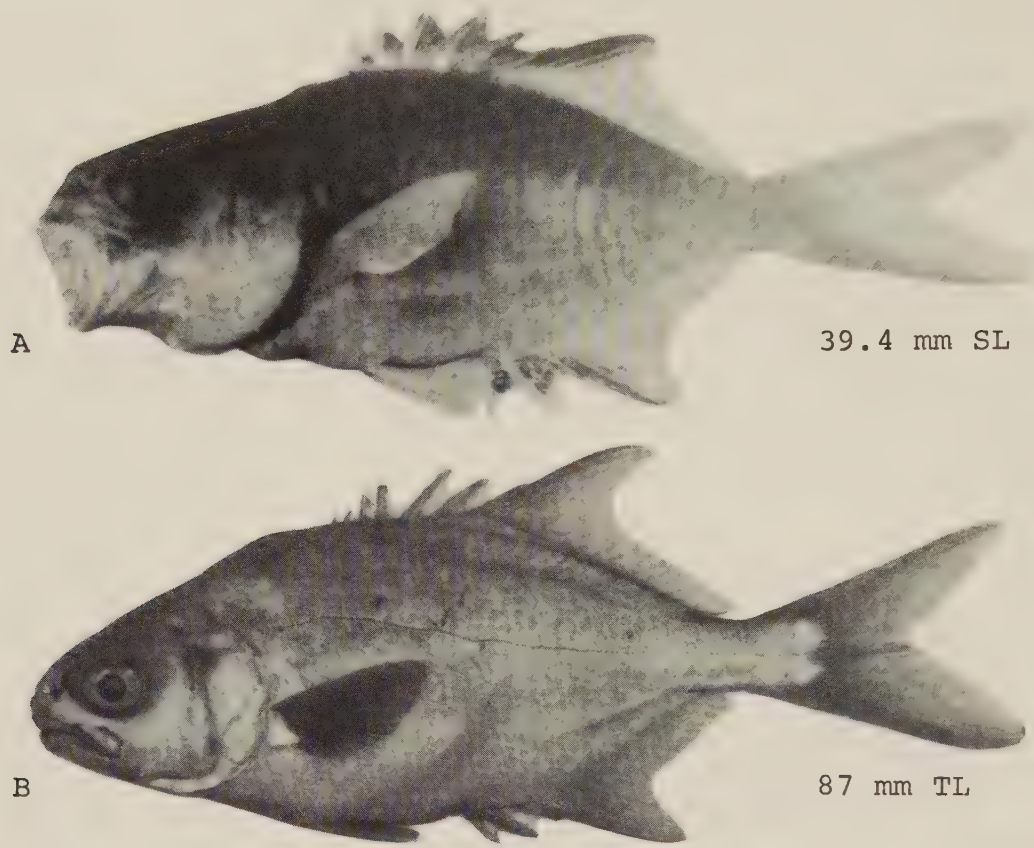

Fig. 73. *Trachinotus goodei,* Palometa. A. Juvenile, 39.4 mm SL. B. Juvenile, 87 mm TL. (*A, Fields, H. M., 1962: fig. 17 lower. B, Ginsburg, I., 1952b: pl. 4, fig. a.*)

examined. Anal fin lobe also first evident at about 11 mm, its relative length developing as follows: 10–20 mm, 22% SL; about 60 mm, 23–27% SL; continues to increase with growth until reaches about 67% SL.[1]

Below 10 mm body depth about 32–36% SL, increasing to about 48–50% at 130 mm.[1]

At 10–60 mm gill rakers 3–8 + 9–14; at 60 mm and larger 4–8 + 10–11. At 7.8 mm preopercle with 3 large spines at angle (primary margin spines), 2 secondary margin spines on upper limb, none on lower limb, and 3 distinct spines on lateral face; at 11.8 mm face spines absent, 3 secondary spines on upper limb and 2 on lower limb; at 14.6 mm 3 secondary spines on each limb; at about 23 mm only the middle primary margin spine remaining; by about 28–35 mm this final spine assimilated.[1]

At 7.8 mm teeth present in jaws, and on vomer and palatines as in *T. carolinus,* persisting to at least 140 mm.[1]

Pigmentation: Coloration of fresh specimens 40 mm and smaller similar to *T. carolinus:* dull silvery above, light gray to white below; dorsal fin lobe black; anal fin lobe cinnamon and black [1] anteriorly; [2,3] spinous dorsal and anal fins pigmented; caudal fin moderately dusky alon upper and lower margins, other fins slightly dusky; n bars evident.[1] At about 50 mm bright silvery, mergin into metallic bluish on back and yellowish on lowe sides and belly; the four dark cross bars very faint, bu usually distinguishable; the first bar very short and lo cated under procumbent dorsal spine, second longer an under fourth spine, third and fourth under soft dorsa dark spot on posterior part of lateral line usually no evident; anterior rays of dorsal and anal and outer ray of caudal black.[14] Above 70 mm upper half of body an head dull bluish gray, grading into white in branchios tegal region, breast, lower sides and belly; dorsal lob black, anal lobe black [1] or clear with black on anterio edge,[2,3] remainder of these fins dusky; pectoral fin slightly dusky; pelvic fins white; caudal lobes very dusk along outer rays, lighter toward inner rays; 5 dar vertical bars on sides.[1]

GROWTH

No information.

E AND SIZE AT MATURITY

nformation.

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Trachurus lathami Nichols, Rough scad

ADULTS

D. VIII–I, 28 [2,3,13]–34 (modally 31); A. II–I, 24 [13]–30 [2,3,13] (modally 28 [3,13]); C. 9+8, procurrent rays 9–10+9–10; [7] P. 20–22; V. I, 5; [13] 68–77 total lateral line scales and scutes, 31–42 scales and scutes in curved lateral line, 32–39 scutes in straight lateral line; [13] vertebrae 10+14; [4,7,13] gill rakers 12–16+33–41; branchiostegals 7; [13] teeth small, virtually in one row in jaws, on head and shaft of vomer and on palatines; teeth in a narow band on tongue.[3]

Body proportions expressed as percent SL: Head about 27.6–32.8 (decreasing slightly above 200 mm SL); depth 24.2–27.5; snout about 8.3–11.4; eye about 7.8–10.0 (decreasing to less than 9.2 above 22 mm); upper jaw 10.7–12.9; pectoral fin 26.8–32.8 above 100 mm; pelvic fin 16–18.2 to 100 mm SL, 14–16.2 above 170 mm SL.[13]

Body slender, spindle shaped; caudal peduncle slende anus placed near first anal spine; snout moderate, obtus subequal to eye; adipose eyelid well developed, particu larly posteriorly; mouth medium, well inclined, termin or subsuperior; lower jaw subequal to upper or a litt projecting, maxillary of moderate width, ending unde anterior margin of eye; supramaxillary present. Scale small, antedorsal area scaled to opposite middle or a terior margin of eye; cheek, opercle and interoperc nearly all scaled; scales on membranes between anteri 3–4 rays of second dorsal and anal fins and on mem branes between most rays of pectoral, pelvic, and caud fins; low scaled sheath along bases of dorsal and anal so rays.[13] Anterior curved part of lateral line rising mod erately, rather abruptly continuous with posteri straight part,[3] the point of junction usually below th eighth or ninth dorsal soft ray; curved part about 1.1

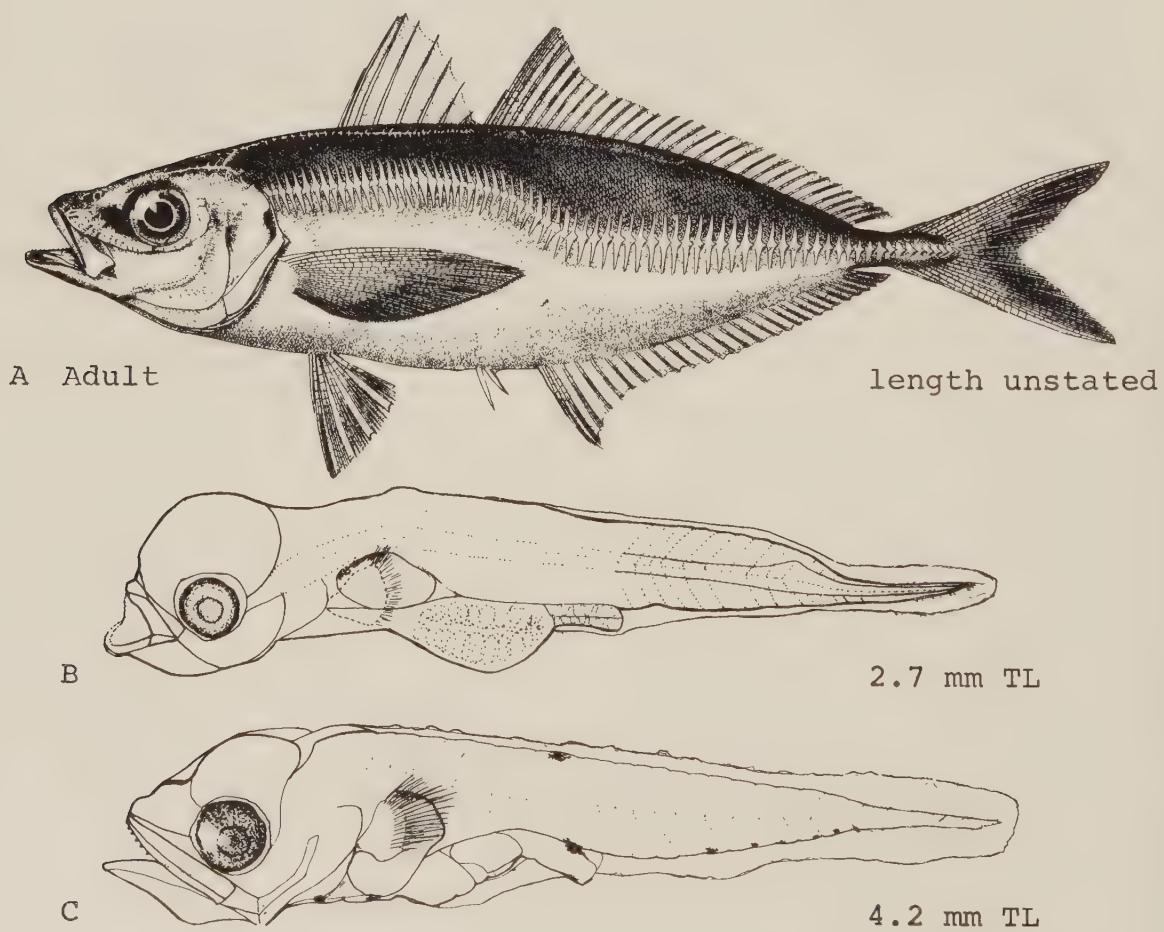

Fig. 74. *Trachurus lathami*, Rough scad. A. Adult, length unstated. B. Yolk-sac larva, 2.7 mm TL. C. Larva, 4.2 mm TL. (*A, Goode, G. B., 1884: pl. 103. B, C, Original drawings by Nancy S. Smith, modified.*)

straight part; [13] scales in anterior part transversely ded to a notable extent, but not spinous and with- keel; scales in straight part scute like, keeled and s; [3] ratio of height of straight to curved lateral line 1.08–1.28; accessory lateral line extending back to en eighth spine and fourth soft ray. Spinous dorsal her high, the spines connected by membranes, the or ones rather flexible; the 2 disconnected anal well developed; dorsal and anal lobes and fold at f fins moderate; caudal fin shorter than head; pec- in reaching beginning of soft anal origin in large ens, falling considerably short in smaller speci- pelvic fin reaching to about half distance from its to soft anal origin.[13] Pectoral girdle without ae,[3] but with a slight furrow on dorsal edge of al ridge.[13]

ntation: Color dusky [3] to bluish green [2] above, ish to golden [3] or silvery [2,3] below; opercle with a al spot typically present in larger specimens, often or hardly perceptible; no particularly distinctive marks.[3]

cterized by having enlarged scutes along entire line, no detached finlet behind dorsal or anal fin, papillae or furrow on pectoral girdle.[2]

num length: Reach at least 305 mm SL.[13]

RIBUTION AND ECOLOGY

: Western Atlantic from Gulf of Maine to northern tina.[13]

distribution: Upper Chesapeake Bay, Maryland; [1] on Inlet, New Jersey; [10] Indian River Inlet, are.[6]

at and movements: Adults—generally found farther re than other coastal pelagic species, most common- ween about 50–90 m; [8] frequently taken on or near n, but probably also occur up in water column and e near surface.[1] Common off Texas sporadically g summer; [5,9] rare in Massachusetts and New York ate August to November.[11] Taken in salinities from 14.0 [1]–38.7 ppt [12] and temperatures from 14.4– [2]

e—3 specimens, 3–5 mm, taken at Indian River Delaware in June.[6]

les—have been taken far offshore; sometimes asso- with jellyfish.[2] Taken in New Jersey at salinities 30.5 ppt and temperatures of 14–18.5 C.[10]

SPAWNING

Smallest specimens taken in May [12] or June.[6]

EGGS

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Numerous chromatophores usually dispersed conspicuously between posterior lateral line and anal fin base to at least 50 mm.[14]

GROWTH

Juveniles probably range up to about 75–80 mm and yearlings probably average 140–175 mm.[1,4]

AGE AND SIZE AT MATURITY

No information.

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Uraspis secunda (Poey), Cottonmouth jack

ADULTS

D. VIII–I,[3,7] 27[1]–31;[7] A. II–I, 21[1,7]–22 (first 2 spines covered by skin in medium sized fish[1]); C. 9+8 (FHB); P. 22[7]–24; V. I, 5;[3] 45 scales in arch of lateral line,[6] 32–38 scutes in straight lateral line;[1] vertebrae 10+14 (FHB); gill rakers 5–7+14–16;[1] teeth moderately small, in 2 rows in both jaws, those at symphysis of upper jaw and inner teeth of lower jaw moderately larger than others; no teeth on vomer, palatines or tongue;[5] palate and tongue covered with thick membranes.[7]

Head 3.2[6]–3.3,[7] depth 1.9[6]–2.3[7] in SL; snout 3.1[6]–3.2,[7] eye 4.0[6]–4.1,[7] maxillary 2.2, interorbital 2.7, pectorals 1.2, pelvics 1.1.[6]

Body deep, compressed; contour of back a rather steep curve from snout to caudal peduncle; ventral profile a nearly straight descending line to anal origin, thence a nearly straight ascending line to caudal peduncle; snout short, obtuse, moderately longer than eye; mouth small, inclined nearly at a 45° angle, lower jaw moderately projecting; maxillary short, ending under anterior margin of eye; supramaxillary present; adipose eyelid moderately developed. Scales small; body scaled; antedorsal area mostly scaled, the scalation on back extending to an irregular, transverse line above preopercular margin; chest scaleless; area between eye and preopercle scaled, the scales continuing some distance down cheek, continuous with scales on upper part of opercle and preopercle; rest of head, including snout, interorbit and a strip along midback to dorsal origin scaleless; caudal partly scaled, other fins scaleless. Anterior curve in lateral line comparatively long and low, its chord about .7 length straight part; scales in straight part scute-like, the spinous points of the posterior scutes directed forward; accessory lateral line reaching about to dorsal origin. First dorsal low, the spines flexible and connected by a membrane, except the last partly disconnected and pungent; first 4 spines unevenly graduated, the fourth the longest; the 2 disconnected anal spines covered by skin; anterior soft rays of dorsal and anal not forming definite lobes, the folds at their bases present only anteriorly; caudal a little shorter than head; pectoral slightly falcate reaching to end of curve in lateral line; pelvics reaching a moderate distance beyond anal origin.[5]

Pigmentation: Color when fresh, olive green with 8 narrow paler or light gray transverse bands, each narrower than the darker interspaces[5] (bars not evident in specimens larger than about 250 mm[1]); head and base of caudal with brighter olive to yellowish shades; fins all more or less gray to black, well contrasted with body; lower front edge of anal and end of each caudal lobe white; pectoral grayish or a little paler than other fins;[6] tongue milky white, the white color tapering backward along bases of gill arches; palate with a similar whi wedge shaped area tapering backwards, the head of t wedge expanding sideways; frenum behind upper a lower jaws with a median hyaline area, bordered on ea side by a milky white tapering area;[5] remainder mouth cavity dark violet[1] to black.[5]

Distinguishing features are the milky white areas insi mouth and the forwardly directly spines of the late line scutes.[5]

DISTRIBUTION AND ECOLOGY

Range: Worldwide in tropical and subtropical waters (*wakiyai* Williams is a junior subjective synonym of *secunda*, FHB); in the western Atlantic from Massach setts to Brazil.[1]

Area distribution: Monmouth County, New Jersey.[4]

Habitat and movements: Adults—found primarily in c shore waters and around oceanic islands,[1] often in dept of 40–50 m.[3]

Larvae—no information.

Juveniles—no information.

SPAWNING

No information.

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Specimens described 50–109 mm SL.

At about 50–70 mm 26–27 scutes in straight lateral lin

Pigmentation: Specimens from East Africa, 66 mm S

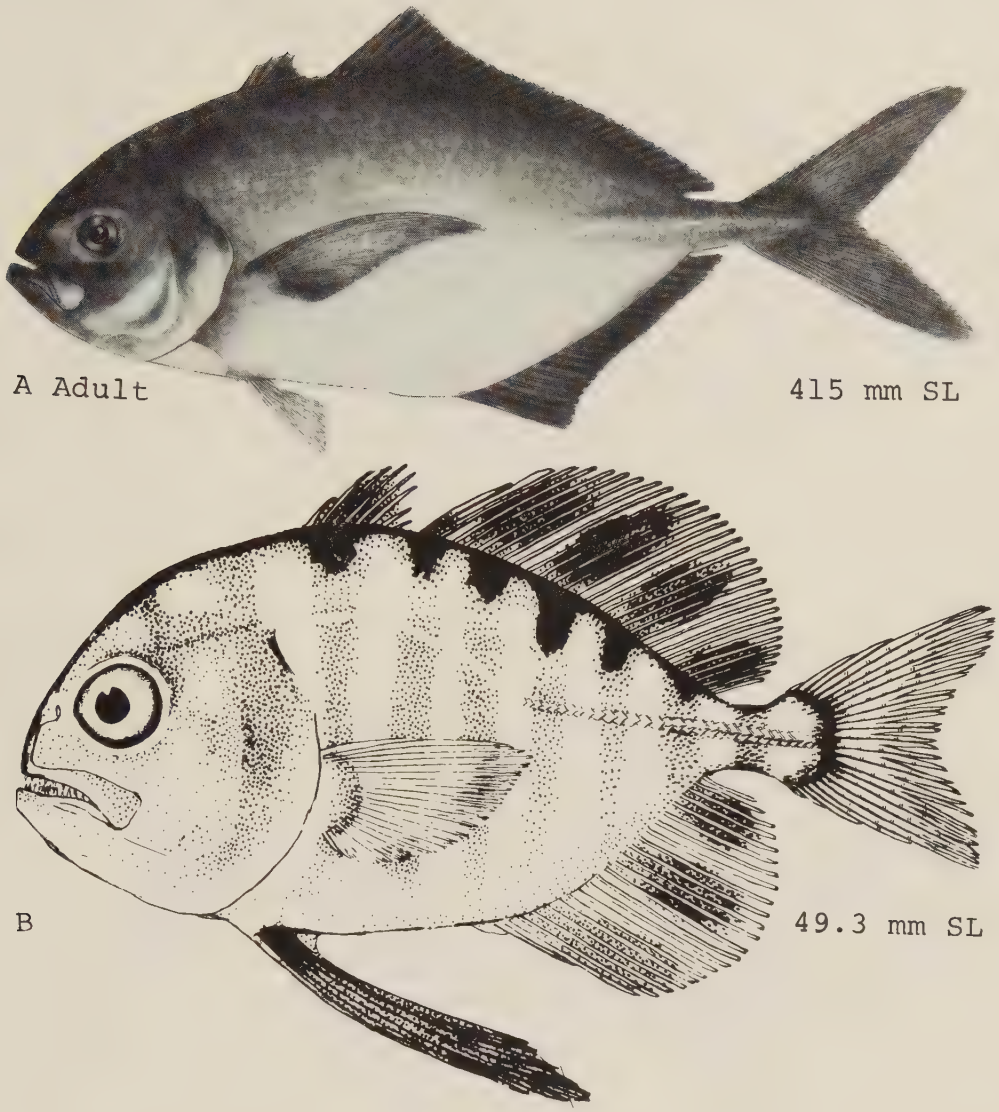

Fig. 75. *Uraspis secunda,* Cottonmouth jack. A. Adult, 415 mm SL. B. Juvenile, 49.3 mm SL. (*Berry, F. H., MS.*)

nalin: head brownish, cheeks and interorbital a arker; remains of a vertical blue brown band on operculum and nape; inside of mouth pale; body sh with several blue brown crossbands wider than aces; first band from dorsal spines through origin toral to just behind pelvic fin base; second from f soft dorsal fin to anus; third from dorsal fin to pines; fourth from dorsal fin through junction of and straight sections of lateral line to front of anal h and sixth from soft dorsal to anal across anterior caudal peduncle; a possible eighth band posterior- audal peduncle; crossbands extending onto dorsal nal fins, but posteriorly becoming very faint s edge of fin; pectoral fin pale except inside base inner part of some rays, and axil dark brown; base and outer rays of pelvic fin pale to dusky, middle rays black, and inside of fin black.[7]

Specimen from off Costa Rica, 109 mm SL: in life black; posterior to head, body coloration broken into 8 black bars by 8 gold spaces expanded at dorsal and ventral ends; third interspace extending through, but not past, scaly sheath covering base of second dorsal fin; dorsal ends of interspaces 4–7 also extending through scaly sheath of second dorsal, their ventral ends extending onto rays of anal fin; 2 oblong gold spots on each of first five black bars, 1 below, the other above or through lateral line; a single triangular gold spot on caudal peduncle; all fins black; axial margin of each pectoral fin transparent; inside of mouth white. After death body color a sooty yellow; the 2 rows of spots and the spot on caudal peduncle scarcely discernible; a black nuchal band evi-

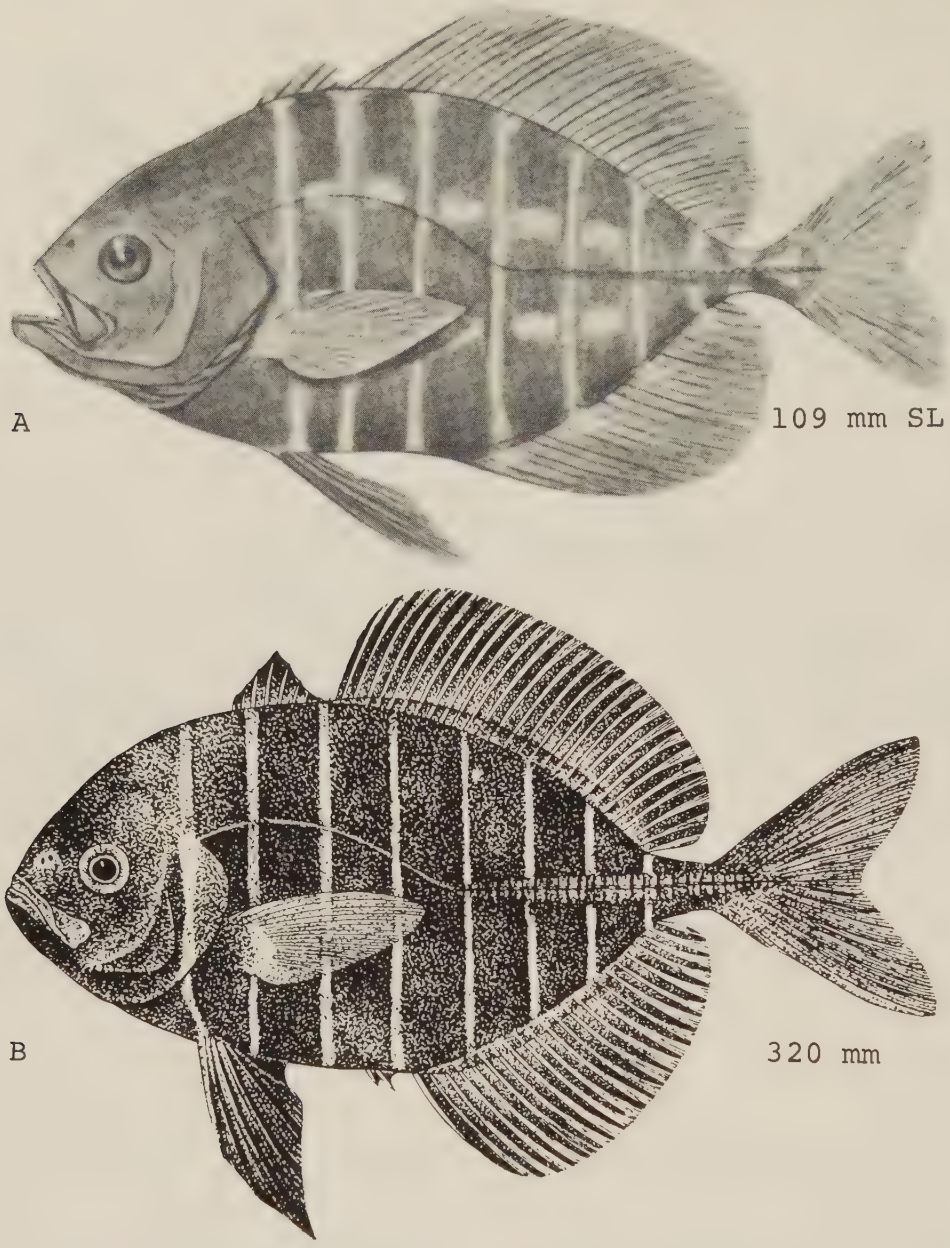

Fig. 76. *Uraspis secunda,* Cottonmouth jack. A. Juvenile, 109 mm SL. B. Juvenile, 320 mm. (*A, Hunter, J. R., and C. T. Mitchell, 1966: fig. 1. B, Fowler, H. W., 1952: fig. 1.*)

dent, extending to dorsal portion of eye. Three months after preservation in alcohol, nuchal band still visible, but spots absent.[2]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Coryphaena hippurus

dolphins
Coryphaenidae

FAMILY CORYPHAENIDAE

This family comprises a single genus with two species, both distributed worldwide in tropical and subtropical waters. Dolphins are typically fast-swimming fishes of the open ocean, but are frequently found inshore along the edges of banks and even within harbors. They feed mainly on fishes, squid, and crustaceans. Only the common dolphin, *Coryphaena hippurus,* is recorded from the Chesapeake Bay region. The pompano dolphin, *C. equiselis,* has been taken as far north as New England, but at a considerable distance offshore, this species tending to be more pelagic.

There is a striking sexual dimorphism in *Coryphaena hippurus.* The adult males develop a steep face and high, rounded forehead and are more brightly colored than the females. The eggs are pelagic.

Coryphaena hippurus Linnaeus, Dolphin

ADULTS

D. 58–66, usually 59–61; A. 25–31, usually 28 or 29; C. 9+8, procurrent rays 10–14+10–14; P. 19–21,[17] usually 19 or 20; V. I, 5; lateral line scales 200–320, usually 245–280;[1] vertebrae 13–14+17–18, usually 13+18;[12] gill rakers 8–9, decreasing in number with age;[1] branchiostegals 7; teeth in jaws and on vomer and palatine cardiform; a patch of villiform teeth on tongue.[9]

Body depth 4 or more in SL in specimens over 200 mm;[1] head 4.7–5.7 in SL;[9] eye 5.2, snout 3.0, maxillary 2.2,[11] pectoral fin 1.5 in head.[9]

Body elongate, compressed, its greatest depth forward of center, becoming attenuate toward tail;[11] adult mal bull-headed,[1] the anterior profile nearly vertical; cleft mouth wide, lower jaw projecting; maxillary reachi middle of eye or beyond. Lateral line complete, its a terior part wavy, its greatest flexure an angular, upwa bend about over center of appressed pectoral fin Dorsal fin single, greatly elevated, extending from na nearly to caudal fin; anal fin similar but shorter, bo without distinct spines; caudal fin widely forked; pector short and small; pelvics well developed, partly receiv in a groove in the abdomen. Body covered with sm cycloid scales;[9] head and operculum mostly scaleless, scaled area below and behind eye.[11] Pseudobran absent.[9]

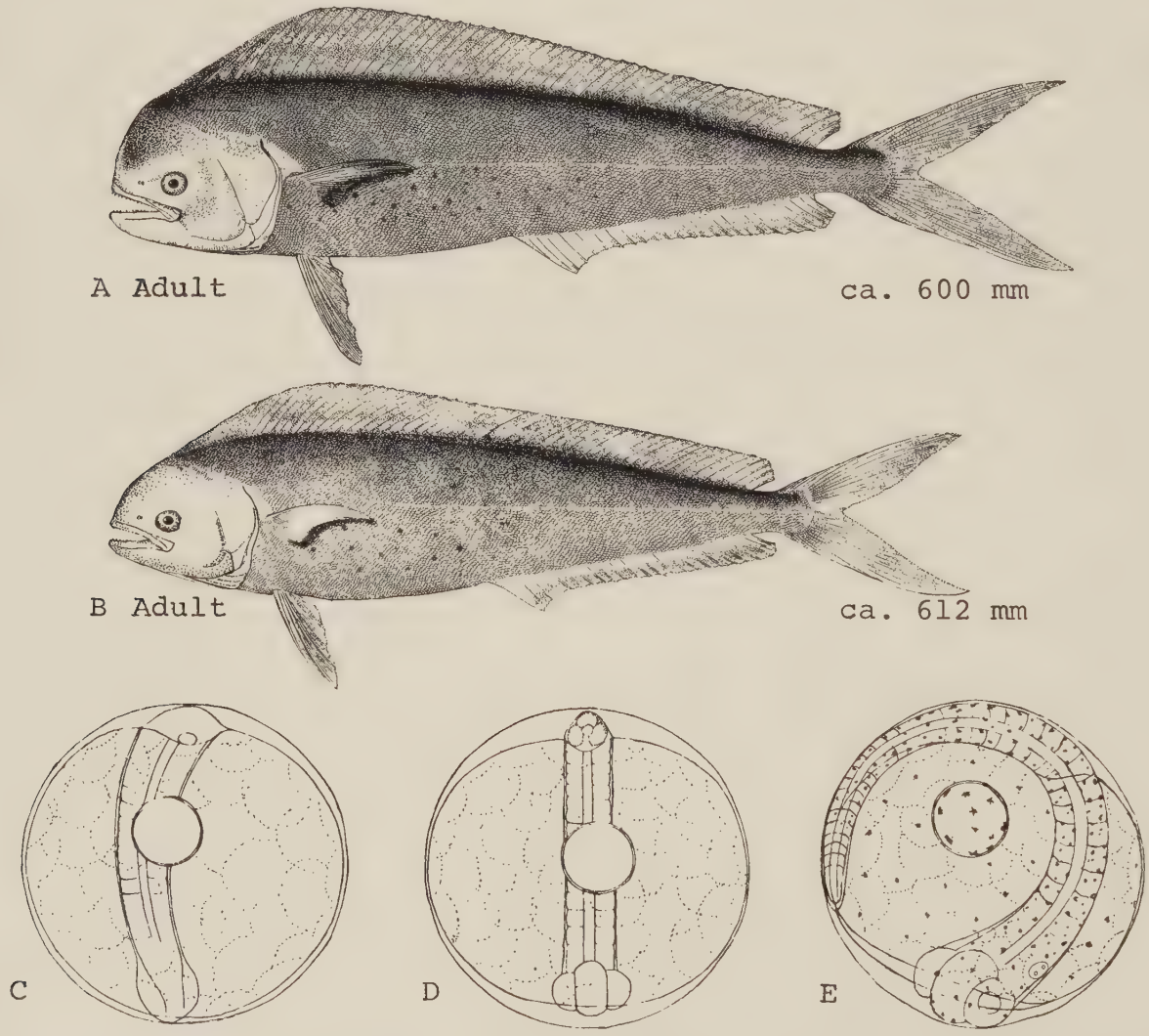

Fig. 77. *Coryphaena hippurus*, Dolphin. A. Adult male, ca. 600 mm. B. Adult female, ca. 612 mm. C. Egg, 5.3 hrs. after capture. D. Egg, 8.3 hrs. after capture. E. Egg, 19.3 hrs. after capture, showing developed embryo with melanophores and xanthophores. (*A, B, Goode, G. B., 1884: pl. 109. C-E, Mito, S., 1960: fig. 1, a-c.*)

Pigmentation: Color in life variable; ground color green, yellow, or silver, overlain with vertical bands or bars ranging from dark olive to black; bars restricted to head and trunk in many, the tail being same color as bars; in others barring uniformly distributed over entire body or completely lacking.[3] Swimming free, a rich, almost turquoise blue with tinges of yellow. Uniformly silvery after death.[1]

Maximum size: Largest recorded 1590 mm.[16]

DISTRIBUTION AND ECOLOGY

Range: Cosmopolitan in tropical and subtropical waters; [1] in the western Atlantic from Nova Scotia and Bermuda to Brazil and throughout the Gulf of Mexico; [14] rare north of Cape Cod.[1]

Area distribution: Ocean City, Maryland; [1] York River, Virginia; [15] Atlantic, Cape May, and Ocean counties, New Jersey.[10]

Habitat and movements: Adults—pelagic, closely associated with floating and drifting objects on the high seas; [4,18,19] common at certain times in Caribbean, Gulf of Mexico, Florida Current, and Gulf Stream; particularly abundant in Gulf Stream in June; caught by sportfishermen in considerable numbers along U.S. Atlantic coast where Gulf Stream comes close to land—southern Florida, Cape Hatteras, North Carolina and Ocean City, Maryland; most abundant off Puerto Rico from January to March, absent in summer, and moderately common from October to December. General range probably best described by 20 C isotherm. Greatest concentrations generally found over depths from 0–36 m and 180–1800 m.[1]

Larvae—no information.

Juveniles—tolerate coastal waters, being taken occasionally in turbid waters and shallow water near docks; [1] often congregate near drift lines where they drift beneath flotsam; [6] abundant in Gulf Stream in June, September,

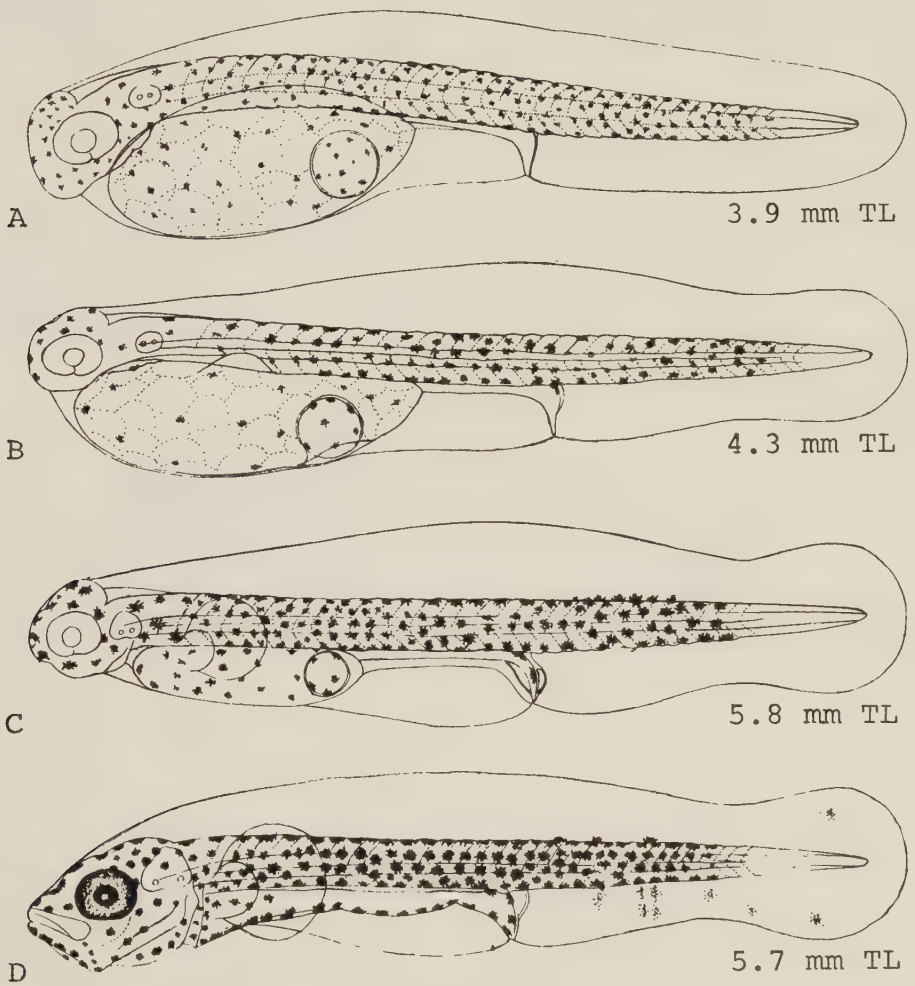

Fig. 78. *Coryphaena hippurus,* Dolphin. A. Yolk-sac larvae, newly hatched, 3.9 mm TL. B. Yolk-sac larva, 5–7 hrs. after hatching, 4.3 mm TL. C. Yolk-sac larva, 1 day after hatching, 5.8 mm TL. D. Larva, 4 days after hatching, 5.7 mm TL. (*Mito, S., 1960: fig. 1, d-g.*)

and October, uncommon in March and April.[1]

SPAWNING

Location: In western Atlantic, probably occurs mostly south of Cape Kennedy, Florida [8] but ripe females have been taken off Ocean City, Maryland.[1]

Season: Off Maryland in July and August (based on presence of ripe females); in Gulf Stream most intense in early summer; [1] in Florida Current from November to July, peaks in March; [4] off Puerto Rico eggs most advanced in February; spawning probably occurs in response to rising surface temperatures and thus takes place earlier in Caribbean than in Florida Current or Gulf Stream, however there are reports of ripe fish off the Virgin Islands as late as August and throughout year at Miami; spawning probably occurs more than once during a single spawning season.[1]

Fecundity: 80,000–1,000,000 eggs at each spawning, spawn 2 or 3 times a year; fecundity increases sharply with size.[4]

EGGS

Buoyant, spherical, colorless; 1.2–1.6 mm in diameter; yolk coarsely segmented, the segmentation indistinct after preservation; 1 oil droplet, light yellow in color, .3–.4 mm in diameter.[2]

EGG DEVELOPMENT

Many melanophores and xanthophores appear on embryo, yolk, and oil globule during development. Hatch in about 2 days at 24–26 C.[2]

YOLK-SAC LARVAE

3.9 mm at hatching.

Anus somewhat posterior to middle of body; 17+15 myomeres; oil globule situated at posterior part of yolk.[2]

LARVAE

Yolk absorbed at 5.7 mm (4 days after hatching).[2]

Dorsal fin rays first evident at 6 mm NL (start above myomere 24 and proceed anteriorly and posteriorly), developing in all specimens by 8 mm SL. Anal fin rays first evident at 6 mm NL (start about below myomere 23 or 24 and proceed anteriorly and posteriorly), developing in all specimens by 7 mm NL; full complement first observed at 8 mm SL and present in all by 12 mm SL. Full complement of caudal fin rays first observed at 15.6–16.5 mm SL, present in all by 19.5 mm SL. Full complement of pectoral fin rays first observed at 11 mm SL, present in all by 13 mm SL.[17]

Head spination diagnostic: At 10.5 mm sphenotic spine thick and moundlike; supratemporal spine small, sharp, at angle of opercular slit; 2 small spines anteriorly at preopercular angle (sometimes a third); 2 groups of spines in posterior preopercular series, the upper group a pair of long, divergent spines reaching well across the opercle, the lower group consisting of 1 or 2 small spines; supraorbital process quite conspicuous on posterodorsal margin of orbit.[1]

Caudal development: At 5.0 mm NL some caudal support elements present in cartilage near tip of notochord; at 7.0 mm NL flexion beginning, complete by 7.5 mm SL. Ossification sequence for caudal support elements as follows: 8.0 mm SL, urostyle; 9.5 mm SL, neural spine of preural centrum 3, preural centrum 2 and 3 and their autogenous haemal spines, parhypural, hypurals 1–4; 10.6 mm SL first (anteriormost) uroneural and hypural 5; 14.6 mm, the 2 epurals.[20]

Pectoral development: At 5.0 mm NL a simple rod-shaped cleithrum and a coracoscapular cartilage present; at 5.5 mm NL supracleithrum first evident, present in all by 6.3 mm NL at which time posttemporal also evident; at 8.1 mm SL coracoid beginning to ossify; at 9.5 mm SL scapular starting to ossify; at 9.5 mm SL scapula starting to ossify around scapular foramen; postcleithrum beginning to ossify at 9.5 mm SL, not readily seen until 11.9 mm SL; at 11.9 mm SL all 4 radials present, the dorsalmost starting to ossify, all ossifying by 12.3 mm SL; supratemporal first observed at 18.0 mm SL.[17] At 10–20 mm specimens with erected dorsal and anal fins resemble miniature feathers.[1]

Pigmentation: Entire sides of body marked with a pattern of alternating dark and light bars continuing onto dorsal and anal fins, except for posteriormost rays where there is a solid dark patch.[1]

JUVENILES

Full complement of dorsal fin rays first observed at 18.0 mm SL, present in all by 24 mm SL.[20]

By 25 mm sphenotic spine reduced to a welt and supratemporal very short; anterior preopercular series and small spines of posterior preopercular series almost absent. At 35 mm all spines reduced to tiny points except for larger posterior preopercular group. At 38 mm only largest posterior preopercular spines visible. By 40 mm no trace of head spination.[1]

Teeth on tongue not well developed below 75 mm; in larger specimens patch usually ovoid, covering center half of width of tongue.[1] Scales first appear at 100–200 mm FL as minute platelets embedded in rows of scale pockets on caudal peduncle; at 180 mm FL scales easily visible under magnification, with 10–12 circuli and a ra-

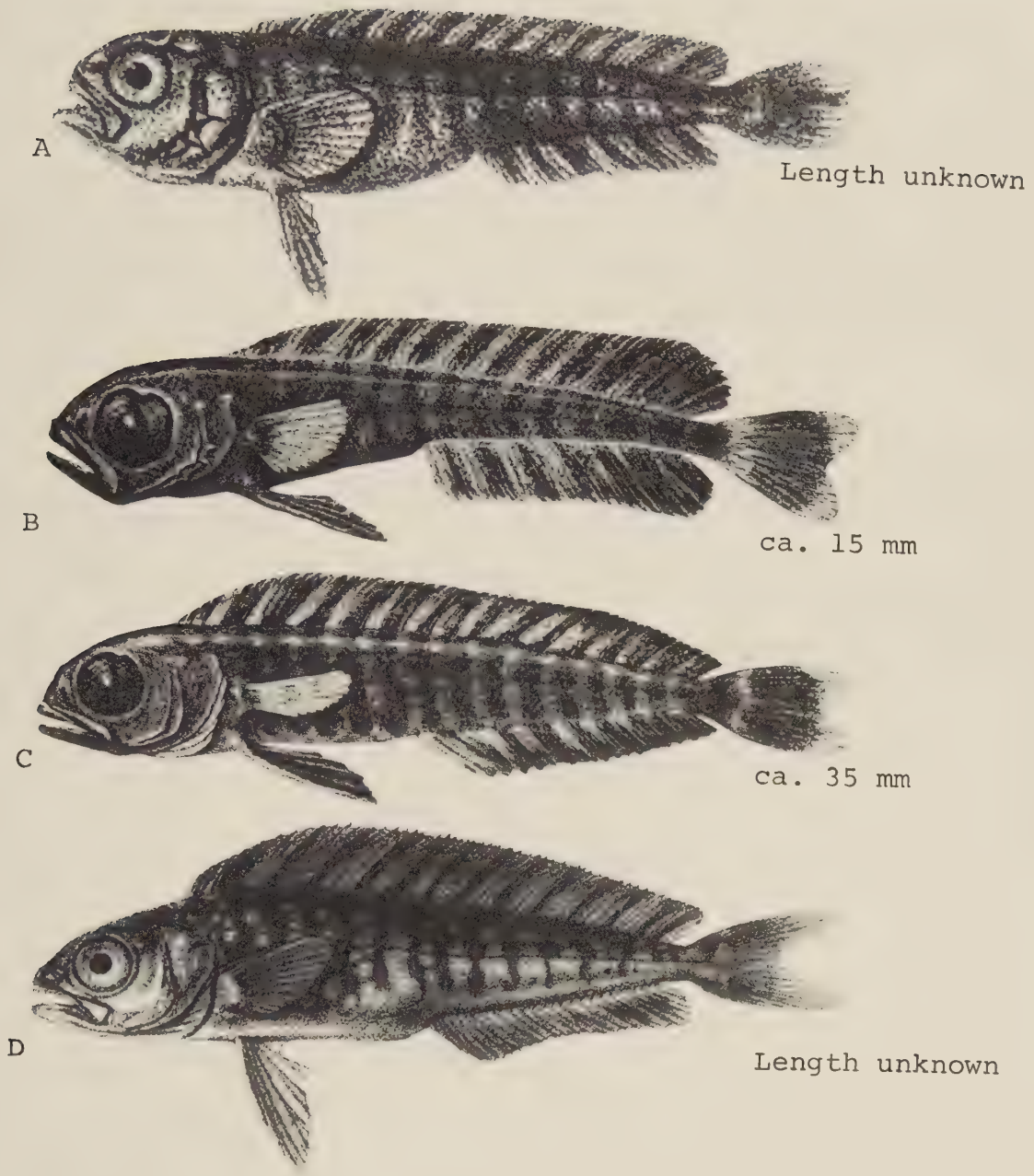

Fig. 79. *Coryphaena hippurus,* Dolphin. A. Juvenile, length unstated. B. Juvenile, ca. 15 mm. C. Juvenile, ca. 35 mm. D. Juvenile, length unstated. (*A, D, Lütken, C. F., 1880: tab. III, figs. 12, 13. B, C, Gibbs, R. H., and B. B. Collette, 1959: fig. 1.*)

dius of about .5 mm; at 200 mm posterior portions of scales begin to break through integument and have 14–18 circuli and a radius of .7 mm.[4]

Caudal development: Between 40–47 mm SL fusion of 2 epurals to 1 accomplished; fusion of 2 uroneurals to 1 occurs between 75–85 mm SL; by 106 mm SL hypurals 1–2 and 3–4 fused to form a dorsal and ventral plate.[17]

Pigmentation: Bars of smaller specimens obscure at sizes much larger than 100 mm; pelvics dark; caudal fin pigmented except for tips of each lobe at sizes smaller than 200 mm.[1] Colors in life variable: When swimming free, mottled with red, orange and gold; upon capture alternating blotches of blue, green, gold, red and orange sometimes appearing as vertical stripes on sides; in captivity darker, dorsal surface dark blue, sides gold and green, ventral surface pale.[5]

GROWTH

Very rapid,[4] averaging 2–5 mm/day,[5] 725 mm in first year, 450 mm in second year; a captive male grew from .5 kg to 16.3 kg in about 8 months; at same age, males larger than females.[4]

AGE AND SIZE AT MATURITY

May spawn in first year;[1] maximum life span about 4 years, but few live to this age.[4,13] Females begin to mature at about 350 mm (slightly smaller than males), 50% mature at 450 mm, 100% mature by 550 mm.[1]

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Taractichthys longipinnis

pomfrets
Bramidae

FAMILY BRAMIDAE

The family Bramidae includes approximately 18 species allocated among 6 genera. With few exceptions bramids are truly oceanic, their distributions generally being correlated with temperature and current structure. Many species are typically small and some are quite rare. Although a number of species occur in the western Atlantic, only one, *Taractichthys longipinnis*, has been recorded from the Chesapeake Bay region.

The family is very poorly known anatomically and difficult to characterize. Even such typically conservative percoid characters as vertebral number and pelvic fin ray count are variable. The general bramid appearance, however, is quite distinctive and all have a single dorsal fin with the anterior spines forming an integral part of the dorsal lobe (when present). In addition all species, as juveniles, adults, or both have spiny or keeled scales and all adults have smooth opercular and preopercular margins.

Larval and juvenile specimens of many species have been described, however, developmental information for most is incomplete.

In general, considerable morphological changes occur with growth, often continuing into late juveniles and young adults. The young of all species are pelagic (Mead, 1972).

Taractichthys longipinnis (Lowe), Bigscale pomfret

ADULTS

D. 33–38, 5 or 6 graduated, unbranched rays anteriorly, the remainder branched; A. 27–30, 4 or 5 graduated, unbranched rays anteriorly, the remainder branched; P. 20–22;[4] V. I, 5;[3] scales 39–46 in horizontal series,[4] about 20 rows above origin of anal fin;[3] vertebrae 19–21 + 25–26; gill rakers 1–3 + 6–9 on first arch; branchiostegals 7; bands of pointed, recurved, conical teeth in jaws, some external to mouth when closed, the inner anterior premaxillary and mandibular teeth the longest; a narrow band of teeth on palatine, none on vomer or tongue.[4]

Head 4.5,[2] depth 1.6–2.1, pectoral fin 2.4–2.8 in SL; eye 4.5–4.9, snout 3.2–3.8, pelvic fin 3.8–4.4 in head.[4]

Body massive, compressed,[5] anus in posterior quarter of space between origin of pelvic and anal fins; dorsal profile of head between eyes strongly arched and rounded; snout rounded; eye nearly round in small adults, vertically elliptical in larger ones; lower jaw terminal. Head and body, except for lower jaw, snout, free edges of operculum and preoperculum, covered by heavy, spineless scales of highly variable outline; scales on remainder of body with spines (in specimens smaller than 400 mm) which are erect or, posteriorly, antrorse, forming distinct horizontal lines on body; last scale on caudal peduncle distinctly larger than anteriormost scale on central caudal fin rays; bases of paired fins with small, smooth scales; caudal fin lobes almost fully scaled, middle rays naked distally. Dorsal and anal fins moderately stiff, erect, and covered with scales, not depressible into a groove, anterior lobes high and falcate, but changing markedly in shape and height with growth; pectoral fin extending beyond anal fin lobe, pectoral axil with a large deep cavity, roofed above with a band of 5 large scales; pelvic fin short, decreasing in relative length with growth,[4] axil with a well developed axillary process;[3,4] caudal fin broad and stiff, margin evenly concave; transverse caudal grooves well developed. Gill rakers lath-like, longest a little more to slightly less than half length of opposing gill filament.[4]

Pigmentation: When fresh, body suffused with dark crimson or violet, snout pale to flesh colored.[3] In preservative body brownish or bronze above, many of the scales with dark vertical marks, silvery laterally and ventrally; dorsal and anal fins silvery, with blackish margins anteriorly and at tips of prolonged portions, continued submarginally along the short rays, the tips of which are white and project beyond the black stripe; pectoral fin blackish above, grayish below; pelvic fins black with white tips and white internal edge; caudal fin with black upper and lower margin, the concave portion with white margin and black submarginal band; iris brownish, pupil bluish black.[2]

Maximum size: Largest recorded 852 mm.[6]

DISTRIBUTION AND ECOLOGY

Range: Both sides of Atlantic in tropical and temperate regions; in western Atlantic from Nova Scotia to the Gulf of Mexico and in eastern Atlantic from Great Britain to South Africa.[4]

Area distribution: Ocean County, New Jersey.[3,4]

Habitat and movements: Adults—typically oceanic to considerable depths, but occasionally taken in shallow waters; may school; lower temperature limit possibly around 10 C.[4]

Larvae—specimens smaller than 20 mm tropical in eastern, western, and central Atlantic (this includes some juveniles).[4]

Juveniles—specimens between 20 and 150 mm known only from the western Atlantic from stomach contents of tunas and *Alepisaurus*.[4]

SPAWNING

No information.

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

To 7 mm.

At 5.1 mm rays formed in anterior half of dorsal and anal fins; fin ray formation complete in dorsal and anal by 5.5–6.5 mm. At 5.1 mm rays formed in caudal fin below urostyle, caudal fin ray formation complete by 5.5–6.5 mm. Pectoral and pelvic fin ray formation complete by 5.1 mm; urostyle straight at 5.1 mm; flexion occurs between 5.5 to 6.5 mm. A diagnostic fringe-like series of short, uniform spines present along anterior and ascending arms of preopercle by 5.5–6.5 mm.[4]

Pigmentation: At 6.5 mm first traces of pigment appear as a few melanophores on gular fold and a light even coloration of anterior half of body; a sharp demarcation evident between white caudal peduncle and fin and darker anterior body.[4]

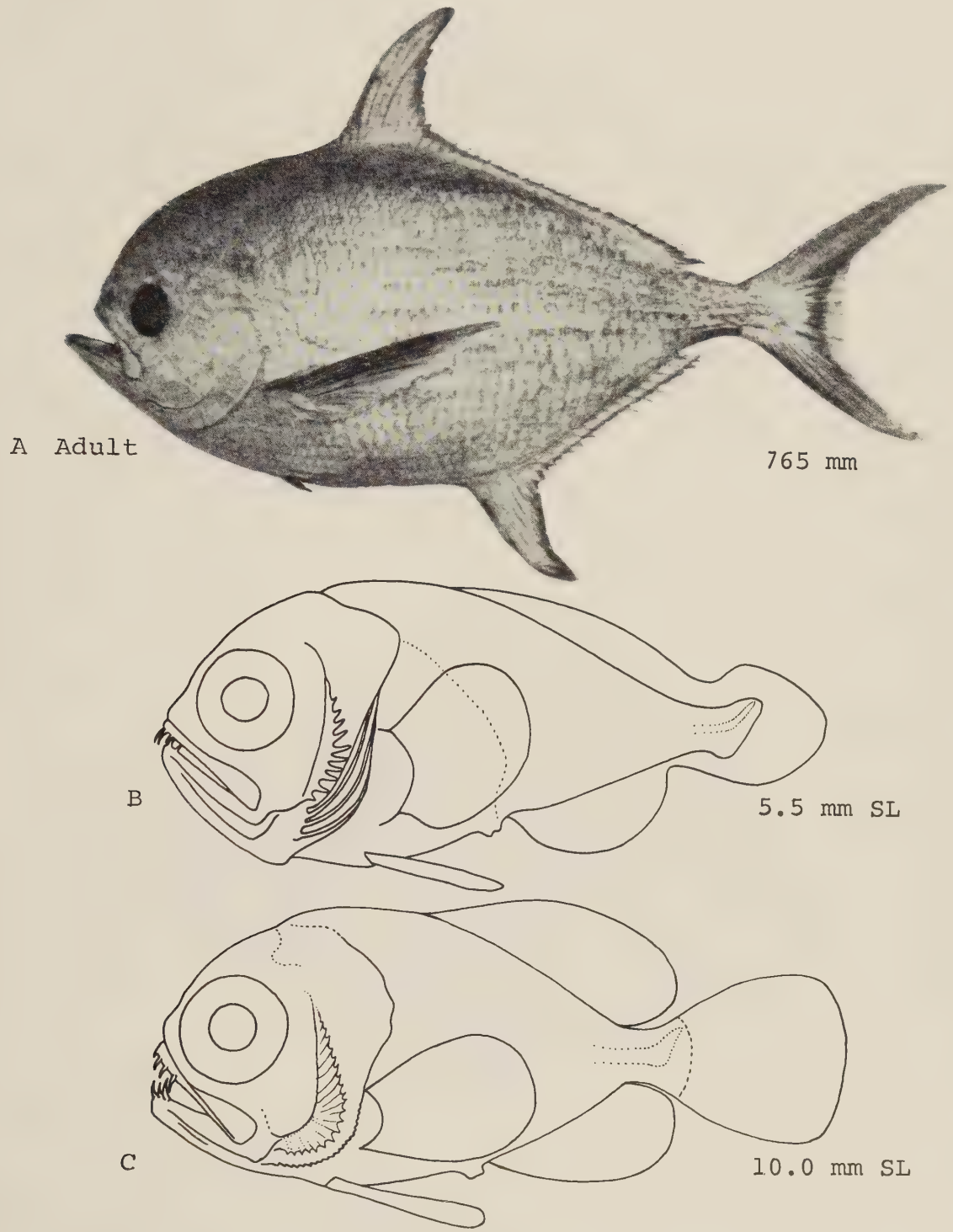

Fig. 80. *Taractichthys longipinnis*, Bigscale pomfret. A. Adult, 765 mm. B. Yolk-sac larva, 5.5 mm SL. C. Juvenile, 10.0 mm SL. (*A, Barnard, K. H., 1948: pl. 10. B, C, Mead, G. W., 1972: fig. 41.*)

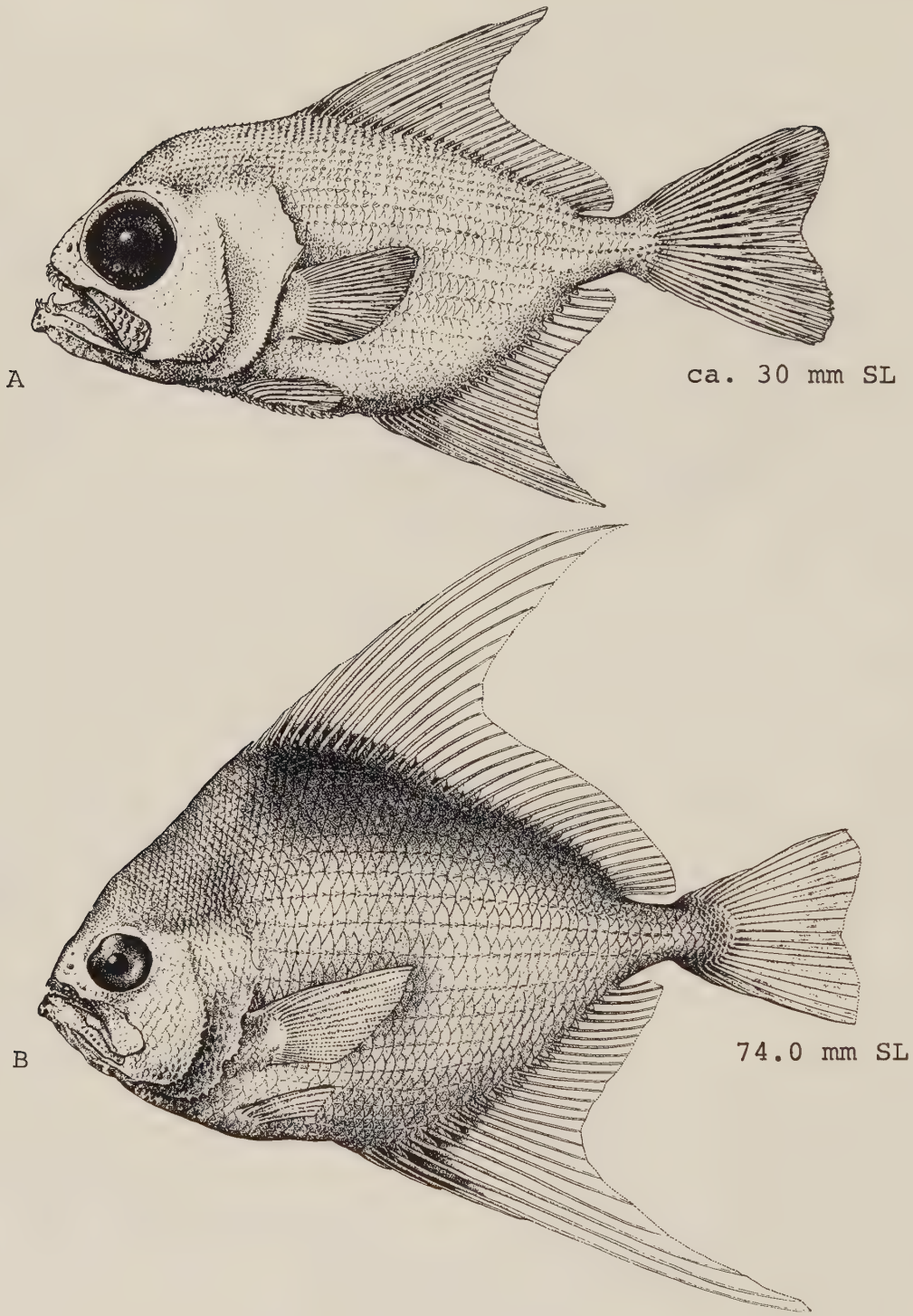

Fig. 81. *Taractichthys longipinnis*, Bigscale pomfret. A. Juvenile, ca. 30.0 mm SL. B. Juvenile, 74.0 mm SL. (*A, Mead, G. W., and Maul, G. E., 1958: fig. 1. B, Mead, G. W., 1972: fig. 40.*)

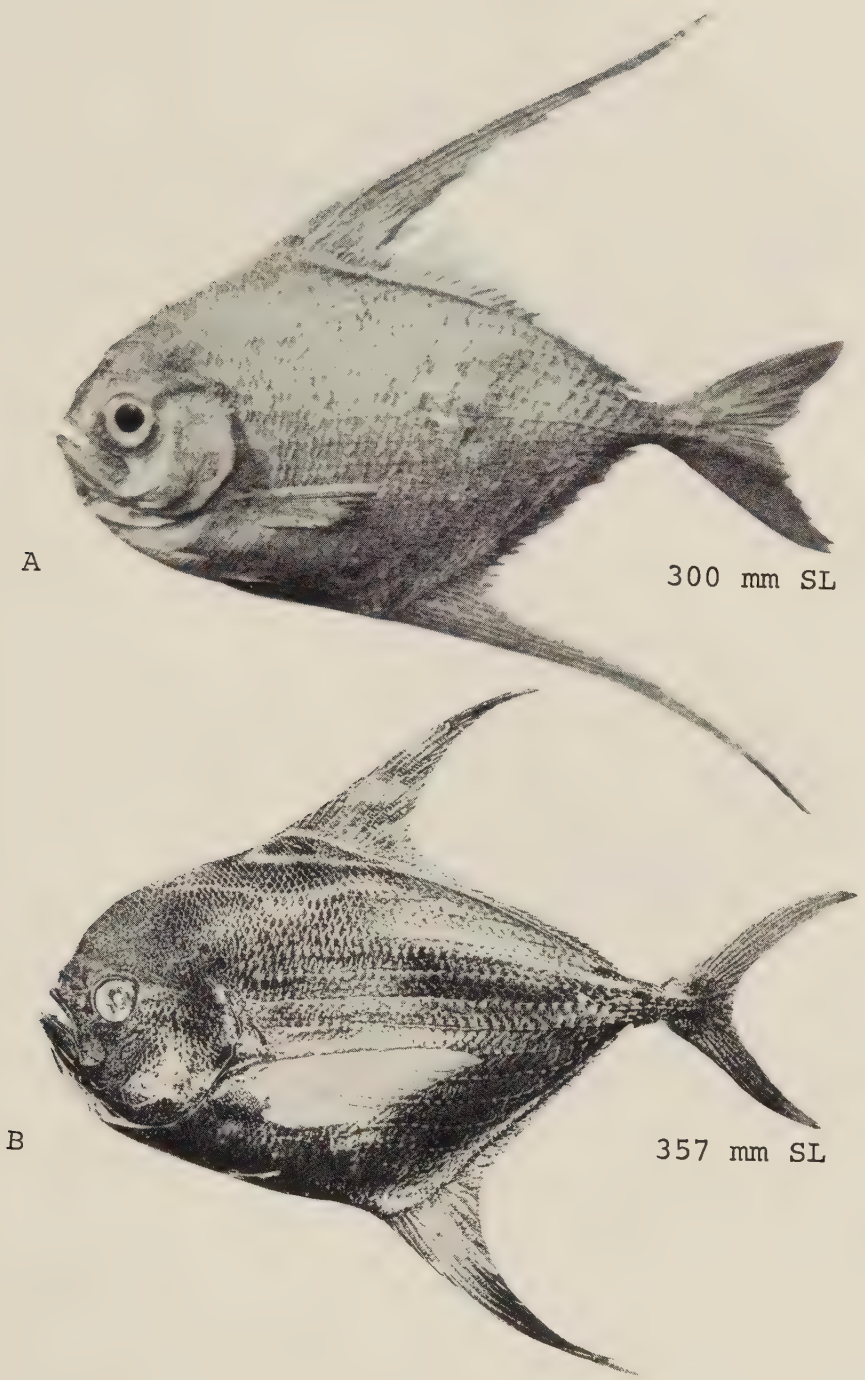

Fig. 82. *Taractichthys longipinnis,* Bigscale pomfret. A. Young adult, 300 mm SL. B. Young adult, 357 mm SL. (*A, Barnard, K. H., 1948: pl. 10. B, Mead, G. W., 1957: fig. 1.*)

LARVAE

n ray formation complete before yolk completely ab-bed,[4] so larval stage, as defined here, does not exist.

JUVENILES

7 mm and larger.

Body scalation complete by 8–9 mm. Below 10 mm teeth

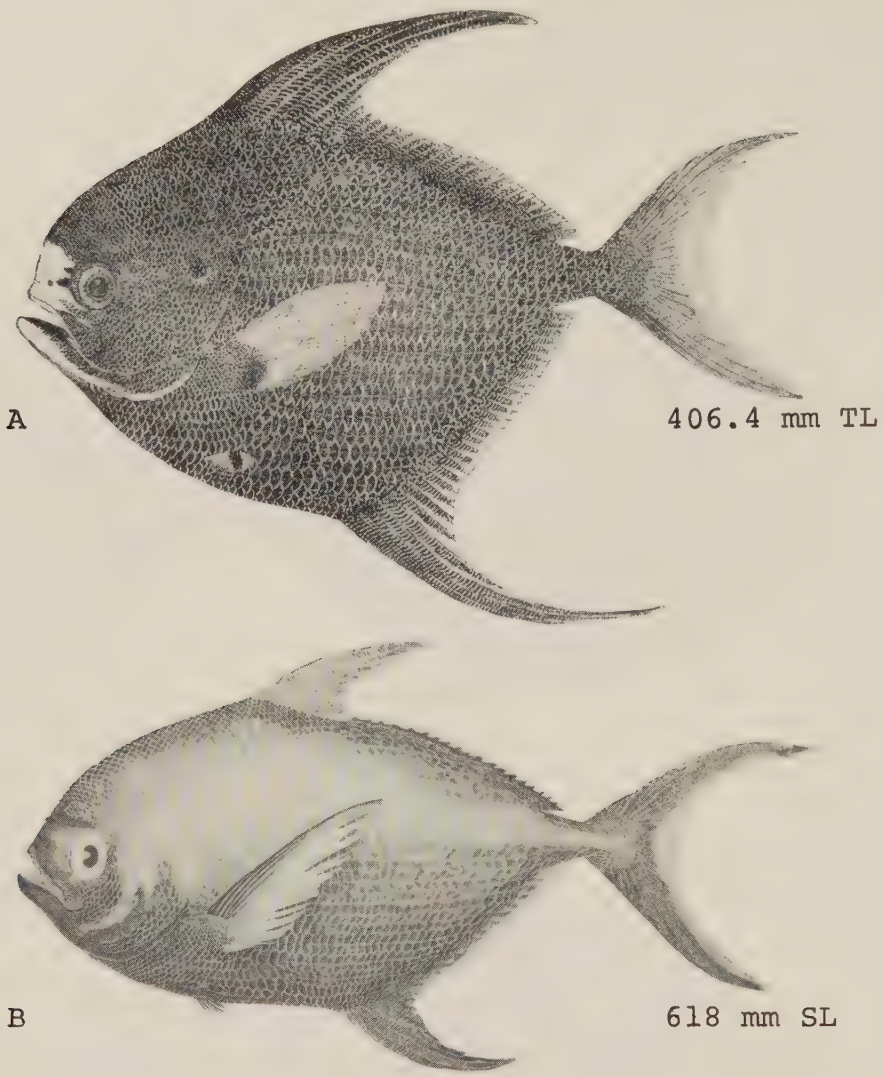

Fig. 83. *Taractichthys longipinnis*, Bigscale pomfret. A. Young adult, 406.4 mm TL. B. Adult, 618 mm SL. (*A, Fowler, H. W., 1956: 4. B, Bigelow, H. B., and W. C. Schroeder, 1929: 362.*)

restricted to 1 to 4 long recurved canines in anterior end of each half of upper and lower jaw; a few minute teeth developing on the posterior parts of both jaws between 10 and 15 mm. Between 10 and 20 mm the following changes occur: Interorbital becomes narrower relative to eye; pelvic fin, which extended to anal fin origin at 10 mm, fails to reach that point; spination on scales increases; pigmentation often appears on pelvic fins. Between 20 and 200 mm major changes in form of body and fins occur (see Fig. 84); at 35 mm scale development on pelvic fins begins, but is still not complete by 110 mm; dorsal, anal, and pelvic fins become darker.[4]

AGE AND SIZE AT MATURITY

No information.

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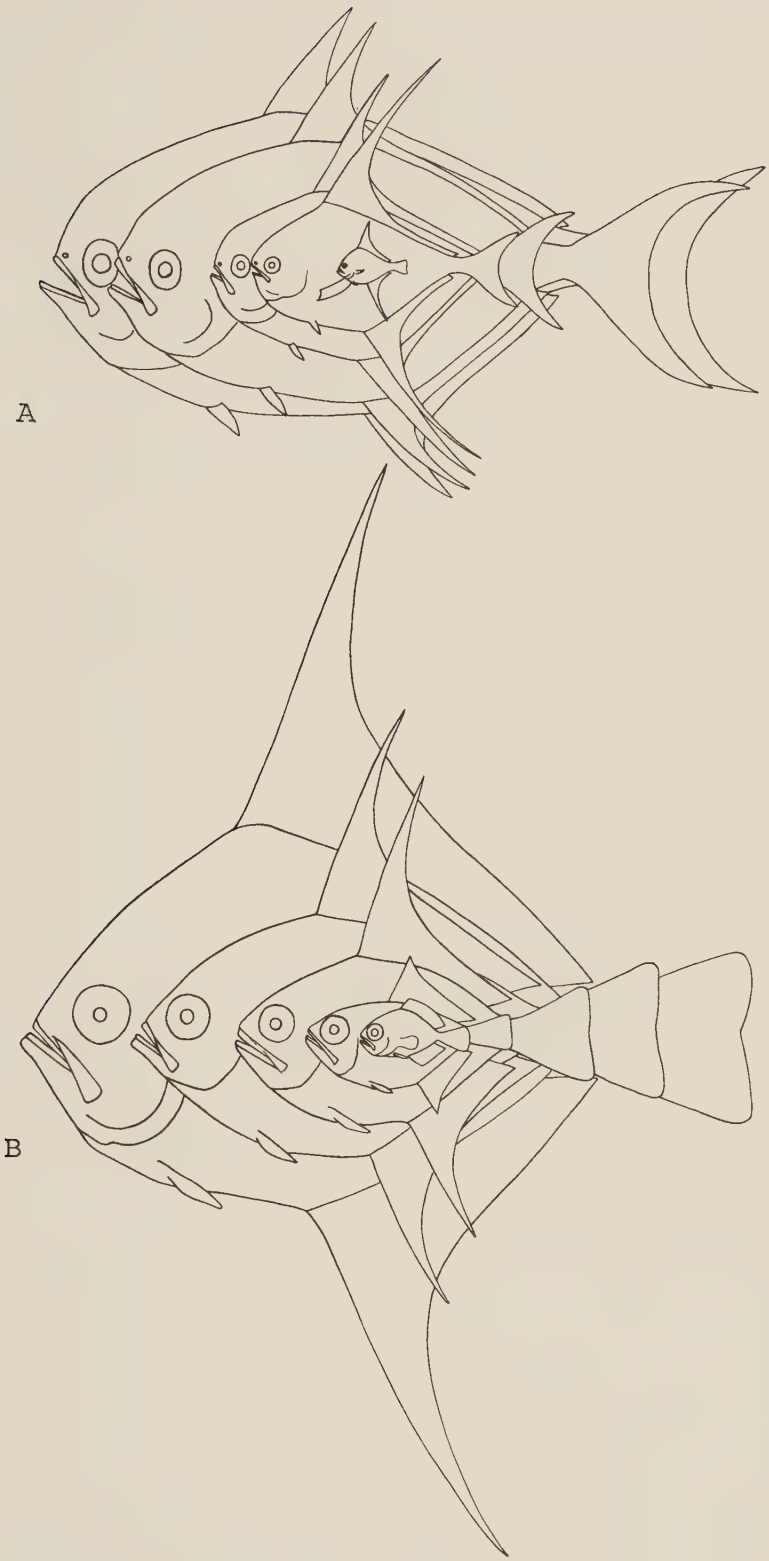

Fig. 84. *Taractichthys longipinnis,* Bigscale pomfret. Changes in body form with growth. A, Back to front: ca. 706 mm, 618 mm, ca. 268 mm, ca. 268 mm, 74 mm. B. Back to front: 74 mm, 51.3 mm, 36.1 mm, 21.0 mm, 10.6 mm. (*Mead, G. W., 1972: fig. 39.*)

Diapterus olisthostomus
Eucinostomus argenteus
Eucinostomus gula

mojarras
Gerreidae

FAMILY GERREIDAE

The Gerreidae includes about 40 species distributed worldwide in tropical inshore waters, a few extending into temperate waters. They are found most frequently on sand or mud bottoms in shallow water and often extend into brackish or occasionally even fresh water. Three species have been recorded from the Chesapeake Bay region.

Mojarras are small, compressed, silvery fishes with deeply forked caudal fins. They have extremely protrusible upper jaws which protrude downward and are used in feeding on a variety of benthic invertebrates. Other significant characters of the Gerreidae are as follows: dorsal and anal fins depressible into a basal scaly sheath; dorsal fin usually with nine spines and 10 soft rays; predorsal configuration 0/0/0+2/1+1/; pelvic fin 1, 5, pelvic axillary process well developed; small teeth present in jaws, none on vomer or palatines; branchiostegals 6; subocular shelf present on second suborbital; supramaxillary absent; vertebrae 10+14; principal caudal rays 9+8; procurrent spur present (GDJ).

Reproductive information on this family is sparse and developmental information is essentially non-existent.

Diapterus olisthostomus (Goode and Bean), Irish pompano

ADULTS

D. IX, 10;[5,7,8] A. III, 8;[5,7,8] C. 9+8, procurrent rays 11+10;[5] V. I, 5;[7] 38–45 scales in a lateral series;[8] vertebrae 10+14;[5,7] gill rakers 10–11 on lower limb;[8] branchiostegals 6;[7] jaws with small, slender teeth, no canines; no teeth on vomer or palatines.[8]

Head 2.8–3.3, depth 2.0–2.7 in SL; snout 3.1–4.0, eye 2.4–3.7 in head.[8]

Body compressed, rhomboid,[7] short and very deep, anterior profile steep;[8] snout conical, blunt; mouth large, little oblique;[7] maxillary reaching slightly past anterior margin of pupil;[8] premaxillaries extremely protractile, the ascending process extending to above eye, closing a deep groove in top of head;[7] premaxillary groove broad and covered with small scales extending forward almost to nostrils (narrower and free from scales in specimens smaller than 150 mm);[8] supramaxillary absent.[7] Dorsal and anal fin margins very concave; second dorsal spine a little shorter than third, second anal spine shorter than third;[8] caudal fin deeply forked, lobes longer than head;[7] pectoral fins reaching to or a little past anal fin origin; pelvic fins reaching to anus, the first soft ray usually with a short filament.[8] Gill rakers short, broad; gill membranes separate and free from isthmus.[7] Preopercle serrate; preorbital entire.[7,8] Second interhaemal spine large, spear-shaped, with a ridge in front and a groove behind. Swim bladder cylindrical, with a narrow tube at posterior end curving upward and forward just in front of interhaemal spines and enlarged at its extremity to form a bulb lying just under the body wall between anus and anal fin origin.[8]

Pigmentation: Color silvery, olivaceous above, paler below; no dark stripes along scale rows; large specimens with dusky punctulations on sides and no trace of bars; spinous dorsal fin with black margin; all fins with dusky punctulations, except pectorals, which are pale with a faint dusky bar at base; anal and pelvic fins greenish yellow in life; snout dusky.[8]

DISTRIBUTION AND ECOLOGY

Range: Chesapeake Bay[4] to Bahia, Brazil, rare north of Florida.[3]

Area distribution: Upper and lower Chesapeake Bay.[4]

Habitat and movements: Adults—euryhaline;[3] in Puerto Rico frequent mangrove channels and river mouths.[2] Taken in salinities from fresh water[6] to 30 ppt[2] and temperatures from 15.8–25.6 C.[6]

Larvae—no information.

Juveniles—common on turtle grass beds in slightly turbid water, also frequent around mangroves and around gorgonians on mud bottoms (FDM); taken in salinities from 0.7–31.3 ppt[9] and temperatures from 16.8[6]–31.8 C.[9]

SPAWNING

Ripe females taken in Puerto Rico in December and April (FDM); smallest specimen (30 mm) in a study in St. Lucie Estuary, Florida taken in May.[6]

EGGS

Figured but not described.[1]

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Four to five faint dusky vertical bars on sides.[8]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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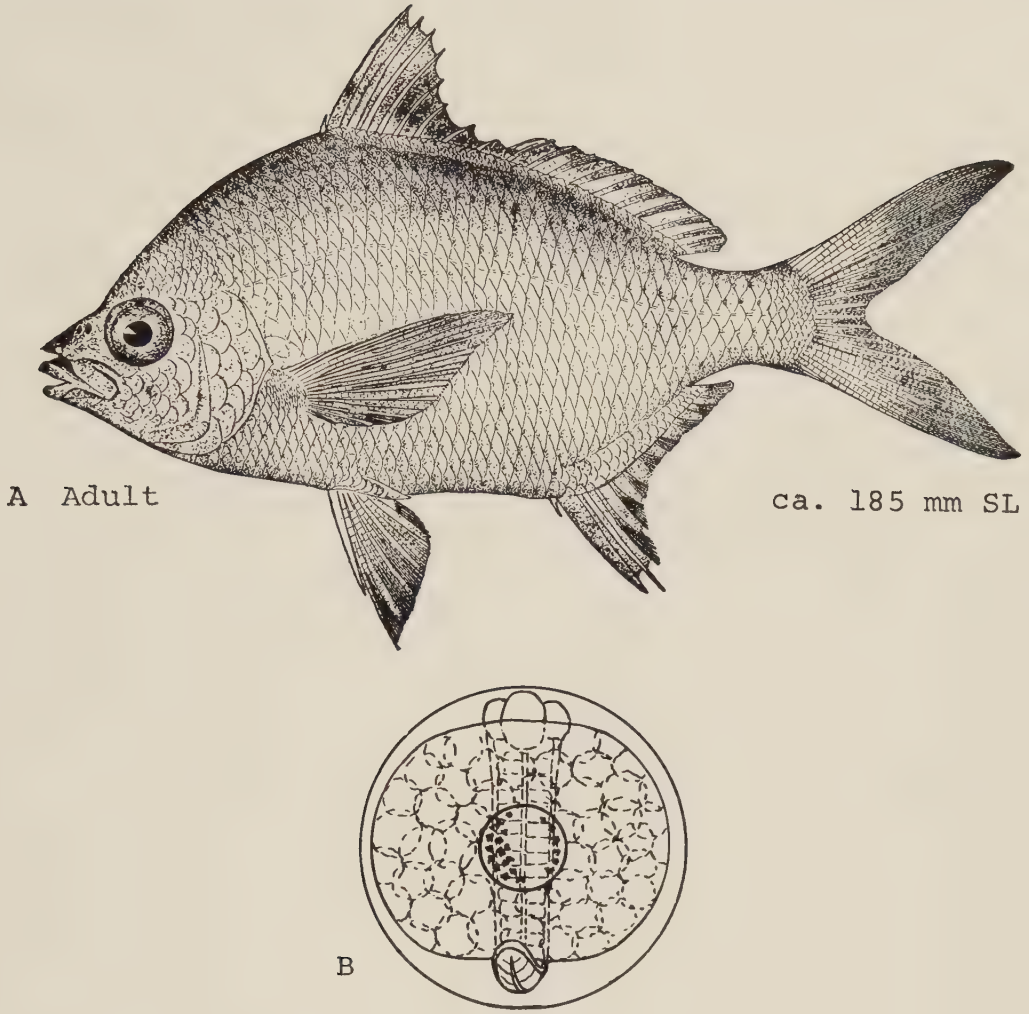

Fig. 85. *Diapterus olisthostomus,* Irish pompano. A. Adult, ca. 185 mm SL. B. Egg (putative). (*A, Evermann, B. W., and M. C. Marsh, 1902: fig. 62. B, Rass, T. S., 1972: 34.*)

Eucinostomus argenteus Baird and Girard, Spotfin mojarra

ADULTS

D. IX, 10; A. III, 7; [4,5,6,13,16] C. 9+8, procurrent rays 10–11+10; [13] V. I, 5; [5] lateral line scales 44–48; [4,16] vertebrae 10+14; [5,13] gill rakers on lower limb 8; [16] branchiostegals 6; small, slender teeth in jaws, none on vomer or palatines.[5]

Head 2.8–3.5, depth 2.6–3.1, pectoral fin 2.8–3.8, pelvic fin 4.3–5.9 in SL. Snout 2.9–3.5, eye 2.7–3.5, upper jaw 2.7–3.1, premaxillary groove 2.1–2.4 in head.[16]

Body compressed, slender, back very little elevated, the curve a gentle one from nape to caudal peduncle; snout rather long and pointed; mouth moderate, nearly horizontal; maxillary reaching anterior edge of pupil, exposed portion triangular; supramaxillary absent; premaxillaries extremely protractile, ascending processes extending to above eye in a deep groove in top of head. Dorsal spines slender,[5] the second not enlarged and a little shorter than third; [6] dorsal fin more deeply notched than in *E. gula;* [14] second anal spine slightly shorter than third; [5,6] pectoral fins scarcely reaching anus; pelvic fins short.[5] Premaxillary groove naked, uninterrupted by a transverse row of scales; [7] posterior part of premaxillary groove narrow, the scales to the side extending anteriorly to front edge of eye, almost to nostrils.[4] Gill rakers short, broad; gill membranes separate, free from isthmus; pseudobranch concealed.[5] Preorbital and preopercle entire.[5,16] Compound interhaemal forming a posteriorly tapering conical receptacle into which swim bladder is tightly inserted and pinched slightly at point of insertion; [2] greatest width of cone 2–2.6 in anterior length of interhaemal.[16]

Pigmentation: Olive buff [16] to greenish with bluish reflections [6] on dark mottling [5] above, silvery below; [6] some with 4 half bands of smoke gray on upper part of sides, and vague blotches and a few interrupted dusky lines along scale rows; [16] spinous dorsal fin with black margin,[4,5,6,16] other fins mostly pale; [5,6] pectoral axil dusky; snout blackish.[5]

Maximum size: Largest recorded about 190 mm.[4]

DISTRIBUTION AND ECOLOGY

Range: Both coasts of tropical America; in the western Atlantic from New Jersey to Rio de Janeiro, including the Gulf of Mexico; [3] in the eastern Pacific from southern California to Ecuador and the Galapagos Islands.[16]

Area distribution: Near Ocean City, Maryland; [10] Atlantic, Cape May and Monmouth counties, New Jersey.[12]

Habitat and movements: Adults—euryhaline; [3] often seen just above bottom on shallow sand flats; [4] appear to be somewhat ecologically separated from *E. gula* in that they show considerable penetration of marshes,[11] however, large specimens seem to prefer deeper, more saline, offshore waters to the bays and bayous and apparently at least some migrate there in the fall.[15] Occur in Chesapeake Bay in late July and August.[10] Taken in salinities from 0.2–45.2 ppt and temperatures from 12.8–36 C,[1] to depths as great as 67 m.[17]

Larvae—no information.

Juveniles—occur commonly in marshes and inshore waters,[8] being somewhat separated ecologically from juvenile *E. gula* which occur primarily in beach and high salinity areas,[15] also common on shallow turtlegrass beds and around red mangrove (FDM). At Bayport, Florida individuals 16 mm or less present in marshes in every month, but at Cedar Key only in May, October and December.[11] Taken in salinities from 3.7 [9]–29.2 ppt and temperatures from 18.9–31.0 C.[8]

SPAWNING

Probably occurs offshore [15] over an extended period; smallest individuals taken May–December in Florida.[9,15]

Fig. 86. *Eucinostomus argenteus,* Spotfin mojarra. A. Adult, 80 mm SL. (*Meek, S. E., and S. F. Hildebrand, 1925: pl. 62, fig. 1.*)

GS

information.

G DEVELOPMENT

information.

LK-SAC LARVAE

information.

RVAE

information.

VENILES

erhaemal cone development: At 15 mm first and sec-d interhaemals fused, the second forming a posterior ace for the triangular, blade-like first interhaemal; at 19 n a slight elevation on anterior margin of first inter-emal; at 21 mm elevation gives rise to 2 diverging nges; at 35 mm flanges expanded to envelop the swim adder, forming a receptacle which opens widest an-iorly and tapers to a slit posteriorly; at 46 mm the nges meet and fuse along the ventral midline to form posteriorly tapering cone into which the posterior rtion of the swim bladder inserts.[2]

gmentation: Smaller specimens often with irregular dark bars and blotches on sides.[6]

GROWTH

No information.

AGE AND SIZE AT MATURITY

Two males, 51.5 and 53.3 mm, in advanced state of gonadal development, but not ripe, taken in St. Lucie River, Florida.[15]

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Eucinostomus gula (Quoy and Gaimard), Silver jenny

ADULTS

D. IX, 10; A. III, 7; [2,17,19] C. 9+8, procurrent rays 10–11+10; [17] lateral line scales 44–48; [2,19] vertebrae 10+14; [3,17] gill rakers on lower limb 8; [19] branchiostegals 6; [3] small slender teeth in jaws, none on vomer or palatines.[3,4]

Head 2.9–3.4, depth 2.2–2.6, pectoral fin 2.7–3.4, pelvic fin 4.1–5.2 in SL. Eye 2.6–3.0, upper jaw 2.7–3.0, premaxillary groove 2.3–2.6 in head.[19]

Body elliptical, moderately compressed, back moderately elevated; [2] anterior profile gently convex, except for slight depression between eyes; mouth small, maxillary reaching to or slightly past anterior margin of orbit; [2,19] supramaxillary absent; premaxillaries extremely protractile, the ascending processes extending to above eye, in deep groove in top of head.[3,4] Scales large, cycloid.[4] Dorsal spines rather weak, second and third almost equal in length; second anal spine shorter but stronger than third; caudal fin forked; pectoral fins long, reaching nearly to anal fin origin; pelvic fins rather short, usually not reaching to anus.[2,19] Naked premaxillary groove interrupted by a row of scales across middle (sometimes incomplete), so that rounded posterior part of groove is completely surrounded by scales [1,2,19] and forms a pit.[4] Preorbital and preopercle entire.[2,19] Compound interhaemal cone-shaped, hollow,[4] greatest width of cone 1.7–2.0 in anterior length of interhaemal; [19] swim bladder with 2 small appendages anteriorly, extending forward to sides of cranium, tapering posteriorly, coming to a point inside hollow interhaemal cone,[2] but not constricted at entrance.[18]

Pigmentation: Silvery with bluish reflections above,[1,2,19] with dark stippling on the median posterior part of most scales on the upper sides creating 4–5 longitudinal lines between curved lateral line and dorsal fin; [19] median fins more or less dusky; spinous dorsal fin with black margin; [2,19] paired fins pale.[1,2,19]

Size: To nearly 180 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: Massachusetts and Bermuda to Argentina including Gulf of Mexico; [1] occurs only as a straggler north of Beaufort, North Carolina.[4]

Area distribution: Chesapeake Bay at Cape Charles City, Virginia.[4]

Habitat and movements: Adults—in shallow water along coast, sometimes into brackish water; appear to prefer clean, sandy bottom, but also taken over oyster beds and mud; [19] in mangrove-lined tidal creeks in Bahamas; [1] at Cedar Key, Florida, most specimens taken from beach areas farthest from marsh.[8] Taken during all months except April, although less abundant or absent in February, March, May, and June; [8,12,13,14] particularly abundant in September.[5,13] Taken in salinities from 0.1–45.2 ppt [10] (usually taken from 24–32 ppt at Cedar Key [13]) from temperatures from 7.2–36 C and to as deep as 67 m.[16]

Larvae—in Texas taken June–October in tide traps and plankton nets.[7]

Juveniles—common on protected beaches with sand or

Fig. 87. *Eucinostomus gula,* Silver jenny. A. Adult, 66.3 mm TL. (*Böhlke, J. E., and C. C. G. Chaplin, 1968: 393, © Academy of Natural Sciences of Philadelphia. Used with the permission of the authors and publishers.*)

ıd and rock bottoms (FDM); specimens 14–17 mm
:t found in July at Cedar Key, Florida,[13,14] but prob-
ly first appear in June and continue to appear until
ecember.[9,14] Taken in salinities from 0.09 [6]–30 ppt.[8]

'AWNING

obably occurs offshore during late winter and
ring,[13,14] however, one ripe female taken in November
Cedar Key,[14] and smallest specimens at St. Lucie estu-
y taken in October and November; [9] in Puerto Rico
e ripe female taken in December and one in April
DM).

GGS

o information.

GG DEVELOPMENT

o information.

OLK-SAC LARVAE

o information.

ARVAE

o information.

JVENILES

o to at least 60 mm, 5 irregular blotches present from middle of sides transversely over back from nape to caudal peduncle.[19]

GROWTH

No information.

AGE AND SIZE AT MATURITY

Mature at least by 81 mm.[14]

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Haemulon aurolineatum
Haemulon plumieri
Orthopristis chrysoptera

grunts
Haemulidae

FAMILY HAEMULIDAE

The family Haemulidae comprises 17 genera, 11 of which are endemic to the New World. This is primarily a tropical group and in the western Atlantic only two genera (three species) out of seven occur as far north as Chesapeake Bay. The common name, "grunt," results from swim-bladder amplified sounds produced by grinding the pharyngeal teeth together.

The overall external appearance of the haemulids is reminiscent of the snappers (Lutjanidae) and this has led to some confusion in the literature. Externally they may be readily distinguished from the lutjanids by the presence of scales on the lacrimal, upper snout, and preopercular flange and by the presence on the chin of a median longitudinal groove, or a pair of pores or both, these being associated with the lateral line system. The absence of canine teeth in the jaws, and of teeth on the vomer is a useful character when dealing only with western Atlantic specimens, but is not valid on a worldwide basis. Osteologically, the haemulids differ from the lutjanids in many characters. Particularly significant are the absence of a subocular shelf, the presence of 26 or 27 vertebrae (versus 24 in lutjanids), the presence of a procurrent spur, the absence of trisegmental pterygiophores in the median fins, and the presence of a rounded vertical flange on the posterior margin of the metapterygoid which overlaps the ventral arm of the hyomandibular. The typical predorsal configuration is $0/0+0/2+1/1/$ versus $0/0/0+2/1+1/$ or $0/0+0/2/1+1/$ in the Lutjanidae (GDJ).

So far as is known, reproduction is by pelagic eggs and there is no parental care (Breder and Rosen, 1966). The eggs possess no particularly distinctive feature. There is one oil globule located at the anterior end of the yolk sac. Developmental information on haemulids is sparse and at present not adequate to allow description of unifying characters other than those characteristic of the adult.

Haemulon aurolineatum Cuvier, Tomtate

ADULTS

D. XII to XIV, 14–15 (usually XIII, 15 [3]); A. III, 9 [1,3,8] (rarely 8 [1]); C. 9+8, procurrent rays 11–12+10–11; [8] P. 17–18 (usually 17 [1,3]); V. I, 5; [7] lateral line scales 49–52, scales around caudal peduncle 22; [1,3] vertebrae 10+16; [8] gill rakers 24–28; [1,3] branchiostegals 7 (GDJ); teeth not strong, outer series enlarged; no teeth on vomer, palatines or tongue.[7]

Head 2.8,[7] depth 2.7–3.7 [3] in SL; snout 2.5, eye 4.2, maxillary 2.0, interorbital 3.7, pectoral fin 1.5, pelvic fin 2.0 in head.[7]

Body elongate, back slightly elevated, anterior profile slightly convex; snout rather long, pointed, eye large; [7] maxillary reaching a point below posterior edge of lens of eye.[1] Scales slightly enlarged anteriorly; [7] longitudinal scale rows below lateral line parallel to longitudinal axis of body.[1,3] Pelvic fin with a well developed axillary process.[7] Gill rakers short.[1,3] Preopercle serrated.[1] Chin with a central groove behind symphysis.[9]

Pigmentation: Color in life silvery white, slightly bluish above, with iridescent reflections; edges of scales of body light yellow, forming continuous light yellow lines, those below lateral line horizontal, those above oblique; [12] a larger bronze to yellow lateral stripe running the length of the body from the eye to a large, dark brown or black caudal spot; [1] a second narrower stripe on back above lateral line; [3] head silvery yellowish above; inside of mouth red; [12] dorsal, anal, caudal, and pelvic fins chalky to light gray; base of soft dorsal and anal fins dusky gray; no black blotch beneath free margin of preopercle.[1]

Maximum size: Slightly less than 250 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: South of Cape Cod to Brazil and along Central American coast throughout Gulf of Mexico; Bermuda population recognized as a separate subspecies by Ginsburg (1948).[1]

Area distribution: Lower Chesapeake Bay.[2]

Habitat and movements: Adults—frequent grass beds and other open areas; [6] found from shore to outer reefs in Florida,[1] being particularly common around offshore reefs; [11] abundant on shrimp grounds of the Tortugas and the Gulf of Mexico; remain to some extent in shallow inshore waters in winter off Florida.[1]

Larvae—no information.

Juveniles—often found in sea grass beds; [3] swarm around shores and wharves near Pensacola, Florida,[12] seek shelter among spines of the long-spined sea urchin, *Diadema antillarum* (FDM). Taken off Florida in salinities from 17.5 to 30.0 ppt [16] and temperatures from 16.2 [11] to 27.1 C,[10] occasionally to about 30 C (FDM).

SPAWNING

May spawn throughout year; [5] ripe females collected in January, April, May, July and August at Port Royal, Jamaica, juveniles observed throughout the year.[4]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Color in life bright olivaceous, grayish silvery below,[12] a dark lateral stripe from behind eye to caudal peduncle continuous with oval caudal spot in smaller specimens, separate from the dumbbell shaped spot in larger ones; [1] above this, 2 or 3 dark streaks, the middle one most distinct, from eye to above gill opening, another from top of each side of snout, passing above eye back to last dorsal ray; a dark streak from tip of snout along median line to front of dorsal; obscure dusky shading below soft dorsal and at base of pectoral; fins plain; anal fin nearly white; pectoral, pelvic, and caudal fins light yellow; lining of opercle plain orange; inside of mouth scarlet.[12]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

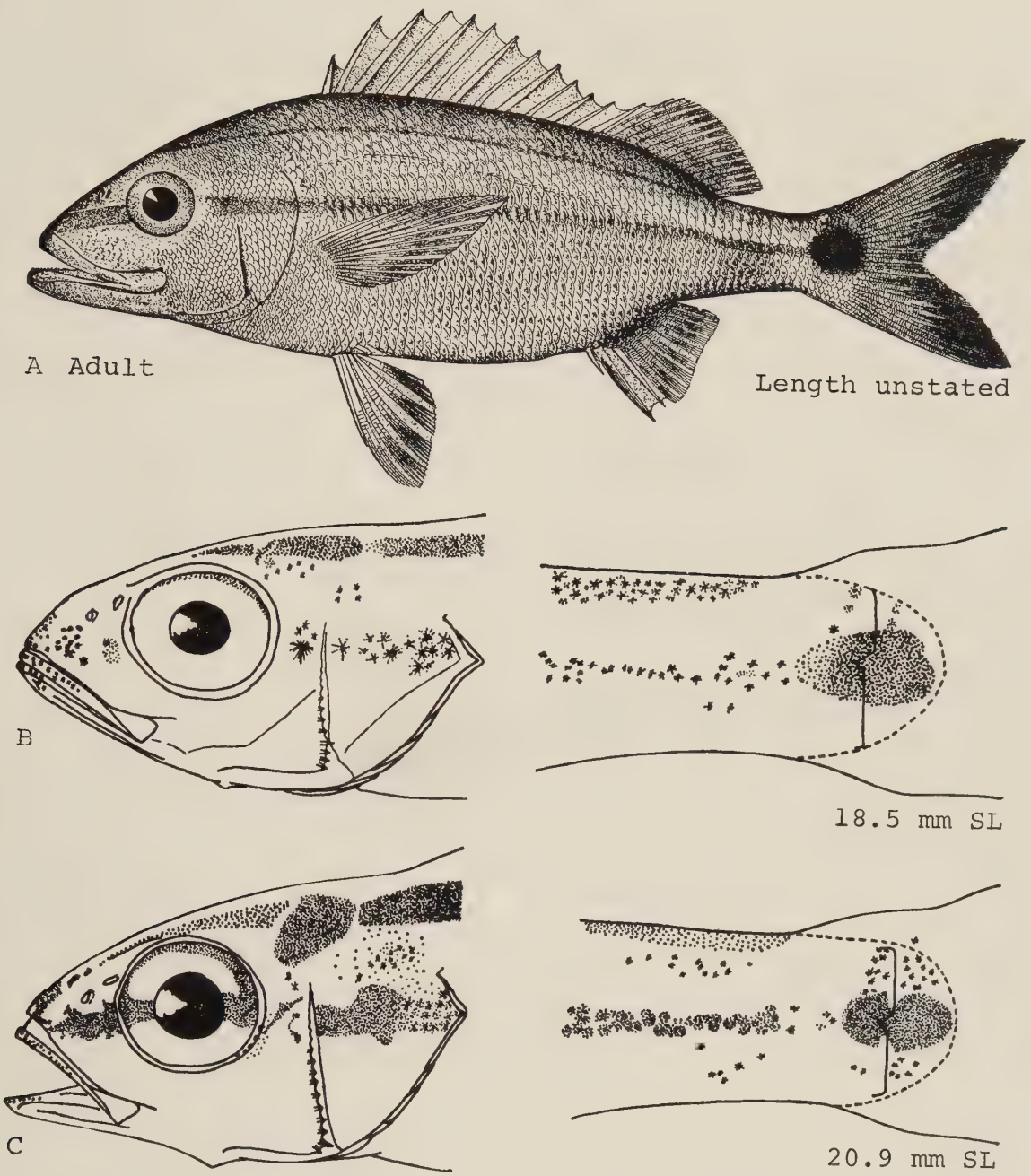

Fig. 88. *Haemulon aurolineatum,* Tomtate. A. Adult, length unstated. B. Juvenile, 18.5 mm SL, head and caudal region. C. Juvenile, 20.9 mm SL, head and caudal region. (*A, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 534. B-C, Courtenay, W. R., Jr., 1961: figs. 13 b-c.*)

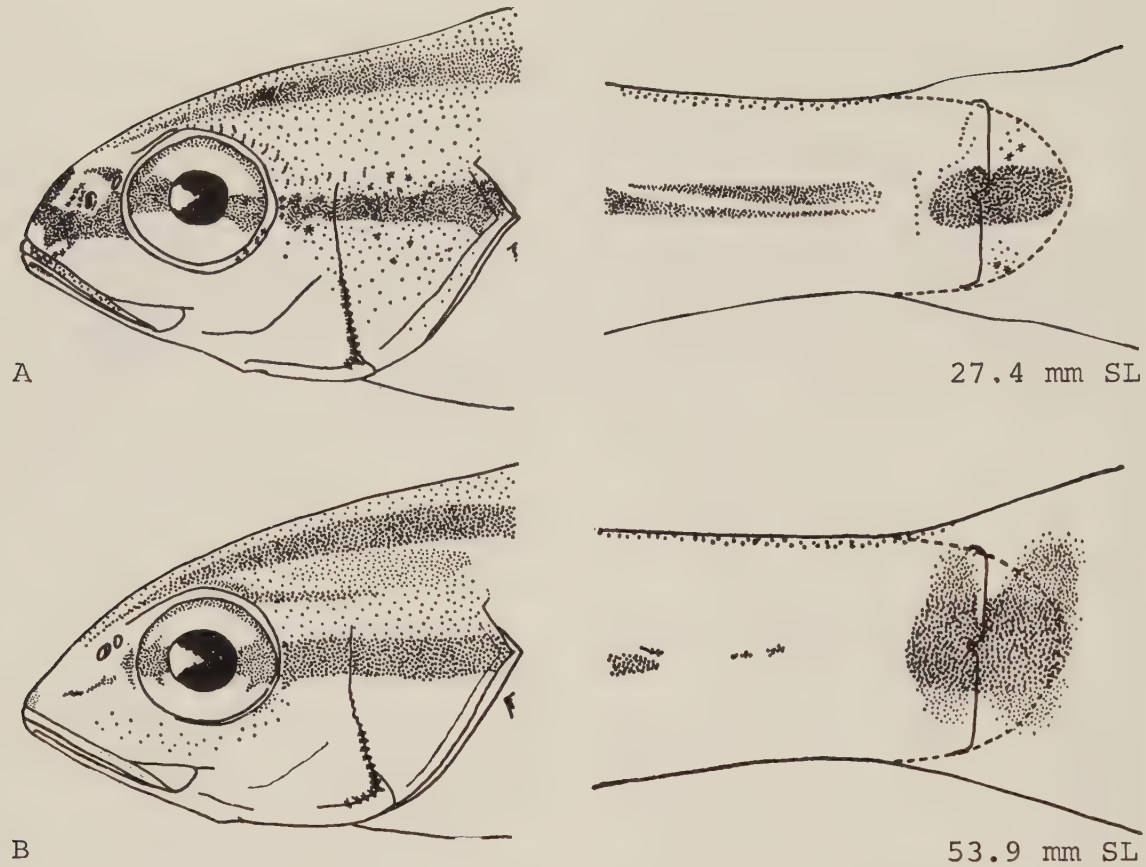

Fig. 89. *Haemulon aurolineatum,* Tomtate. A. Juvenile, 27.4 mm SL, head and caudal region. B. Juvenile, 53.9 mm SL, head and caudal region. (*Courtenay, W. R., Jr., 1961: figs. 13d, 14a.*)

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Haemulon plumieri (Lacépède), White grunt

ULTS

XII, 15–17 (usually 16); A. III, 8–9 (usually 9 [2,5]); 9 + 8, procurrent rays 9–12 + 10–11; [4] P. 17; [2] V. I, 5; [10] eral line scales 48 [2]–52 [5] (usually 50–51 [2]), 5 or 6 scale vs above lateral line; [3] scales around caudal peduncle vertebrae 10 + 16; [1,4] gill rakers 21–27 (usually 25 [2,5]); nchiostegals 7 (GDJ); jaw teeth conical, outer series nger, curved; [3] no teeth on vomer or palatines.[3,10]

ad 2.5 [10]–2.8,[8] depth 2.4–2.6, caudal peduncle 8.5–9.6 SL; snout 1.9 [8]–2.7,[10] eye 3.9–5.2, maxillary 1.9–2.0,[8] erorbital 3.2–4.0,[10] pectoral fin 1.3 [8]–1.8,[10] pelvic fin [8]–1.8.[10]

dy moderately elongate, back considerably elevated l compressed, head long, snout sharp and projecting, erior profile more or less S-shaped; [10] maxillary long l curved,[4] reaching a point below front of eye,[2] slip- g under lacrimal along most of its length.[10] Soft rsal and anal fins completely covered with scales; dal fin forked; [3,8] pectoral fin long and falcate; pelvic with well developed axillary process.[10] Gill rakers rt.[2] Preopercle slightly serrated.[2,3] Chin with a central ove behind symphysis.[10]

gmentation: Color in life silvery white [3] to cream or white (FDM), head bronze to yellow above; belly l underside of head white; a series of dark blue stripes the head, margined with bronze running back into dy; margin of each scale bronze, posterior edge often y; in a darker phase, center of each scale may appear ite; spinous dorsal membranes chalky to yellowish ite; soft dorsal, soft anal, and caudal fins brownish y; pelvic fins chalky and pectoral fins light yellow halky; a black blotch sometimes present beneath free rgin of preopercle; mouth bright red within.[2] Color ngeable, the whole appearing in a shade which tches the surroundings; over sand near coral, even the kest brassy spots may fade to a straw color; a less mmon phase shows 3 dark lines.[6] Color of preserved cimens grayish brown, scales with large silvery areas, es of head with about 12 wavy horizontal blue stripes, extending beyond head; median fins dusky, paired pale.[8]

ximum size: Reported to reach about 460 mm.[7,10]

STRIBUTION AND ECOLOGY

nge: Chesapeake Bay southward to Brazil and along Central American coast into the Gulf of Mexico,[2] urring only as a straggler north of South Carolina; [8] oduced to Bermuda.[5]

a distribution: Mouth of Potomac River.[14]

Habitat and movements: Adults—found from shore to outer reef; [2] most abundant in Florida from 6 to 24 m,[12] being taken most frequently from moderately deep flats with muddy sand bottom at Cedar Key,[9] in Puerto Rico, most common grunt on shallow turtlegrass beds and around red mangroves (FDM); nocturnal feeders, schooling by day about coral stacks and among gorgonians; [6] spend most of lives in same general area, moving most during spawning when large schools are formed.[12] Recorded from salinities of 18–42.8 ppt and temperatures of 15–33.6 C,[15] some individuals stray into 35 C waters but do not remain long in these areas (FDM).

Larvae—no information.

Juveniles—especially abundant on grass beds at the edges of sand flats [2] during summer and fall,[16] seek shelter among spines of long-spined sea urchins, *Diadema antillarum* (FDM).

SPAWNING

Occurs off Puerto Rico in schools on shoals, rock bottoms in August and September [10] and possibly as early as March; [11] in Jamaica peaks in March and April, decreasing to a minimum in October; [13] in Florida, occurs May through June [12] with perhaps an early migration to deeper water.[9]

EGGS

Pelagic; .9–.97 mm in diameter; chorion transparent, unsculptured and without projections; 1 oil globule, .22–.24 mm in diameter; perivitelline space .03 mm.[1]

EGG DEVELOPMENT

Hatched 20 hours after collection at 24.2 C.[1]

YOLK-SAC LARVAE

2.7–2.8 mm at hatching.

A well developed fin fold present; oil globule located near anterior margin of large ellipsoid yolk sac; gut relatively short; at 3.2 mm pectoral fin fan shaped, without rays; yolk sac and oil globule almost completely absorbed by 48 hours after hatching.[1]

Pigmentation: At hatching white pigment scattered over body and yolk sac, disappearing after preservation; several small melanophores distributed from snout to an area just above the eyes; a few large stellate melanophores on anterior edge of yolk sac, and others along

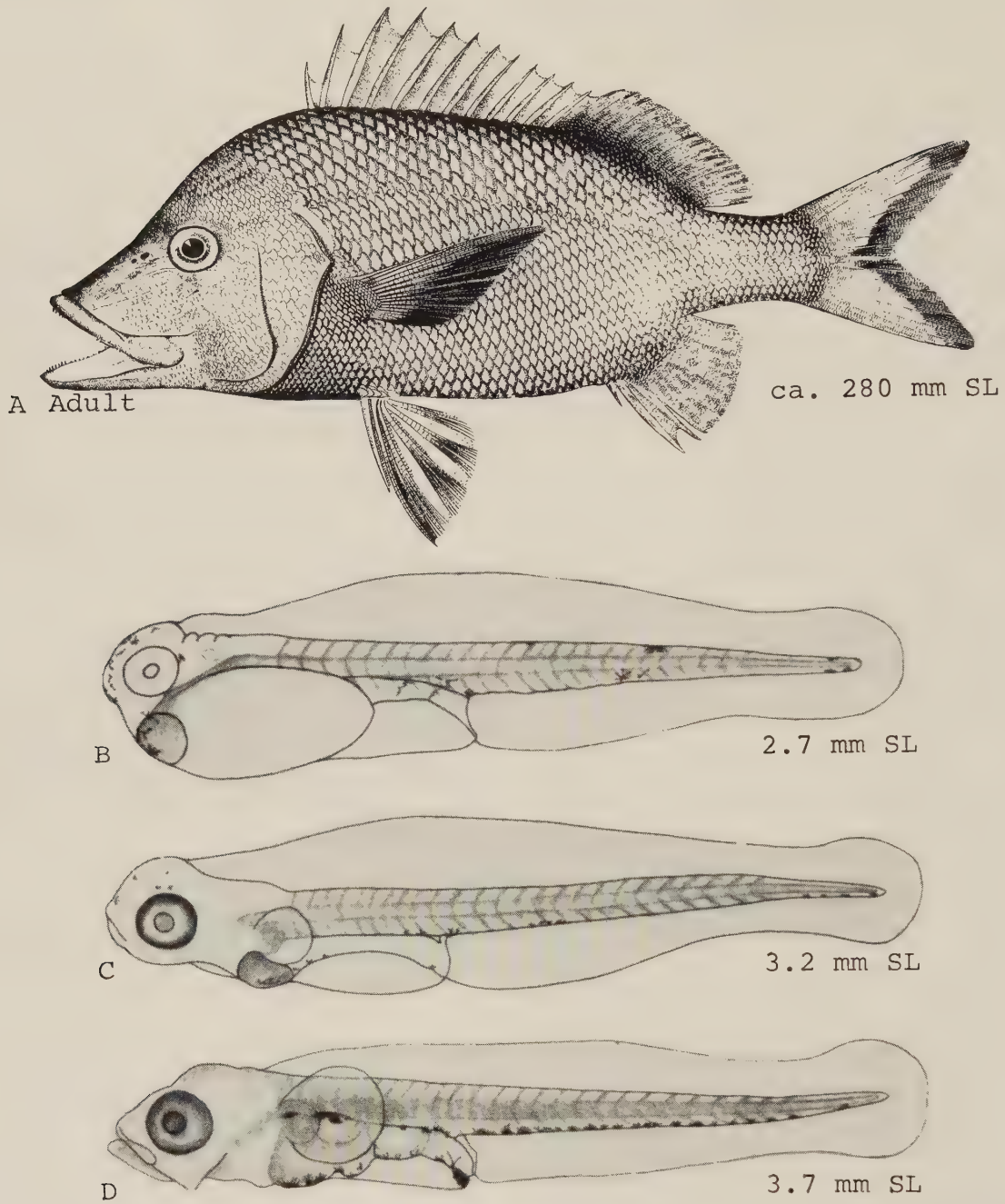

Fig. 90. *Haemulon plumieri*, White grunt. A. Adult, ca. 280 mm SL. B. Yolk-sac larva, newly hatched, 2.7 mm SL. C. Yolk-sac larva, 1 day after hatching, 3.2 mm SL. D. Larva, 4 days after hatching, 3.7 mm SL. (*A, Goode, G. B., 1884: pl. 144. B-D, Saksena, V. P., and W. J. Richards, 1975: figs. 1–3.*)

gut and on dorsal and ventral edges of myomeres in the trunk region; 2 small melanophores present on ventral edge and 1 on dorsal edge of notochord near tip; eyes completely pigmented by second day after hatching.[1]

LARVAE

About 3.7 mm to 9.5–10 mm.

Rayed fins develop in following sequence: caudal, anal and soft dorsal; spinous dorsal and pelvics; pectorals. At 5 mm middle elements of soft dorsal begin to develop, the full complement being reached at 7.9 mm; at 7.9 mm spinous dorsal begins to develop, reaching the full complement at 9.5 mm. Anal fin rays first appear at middle of fin at 5.8 mm; by 6.2 mm 8 soft rays and 2 spines fully developed; by 6.9 mm full complement of

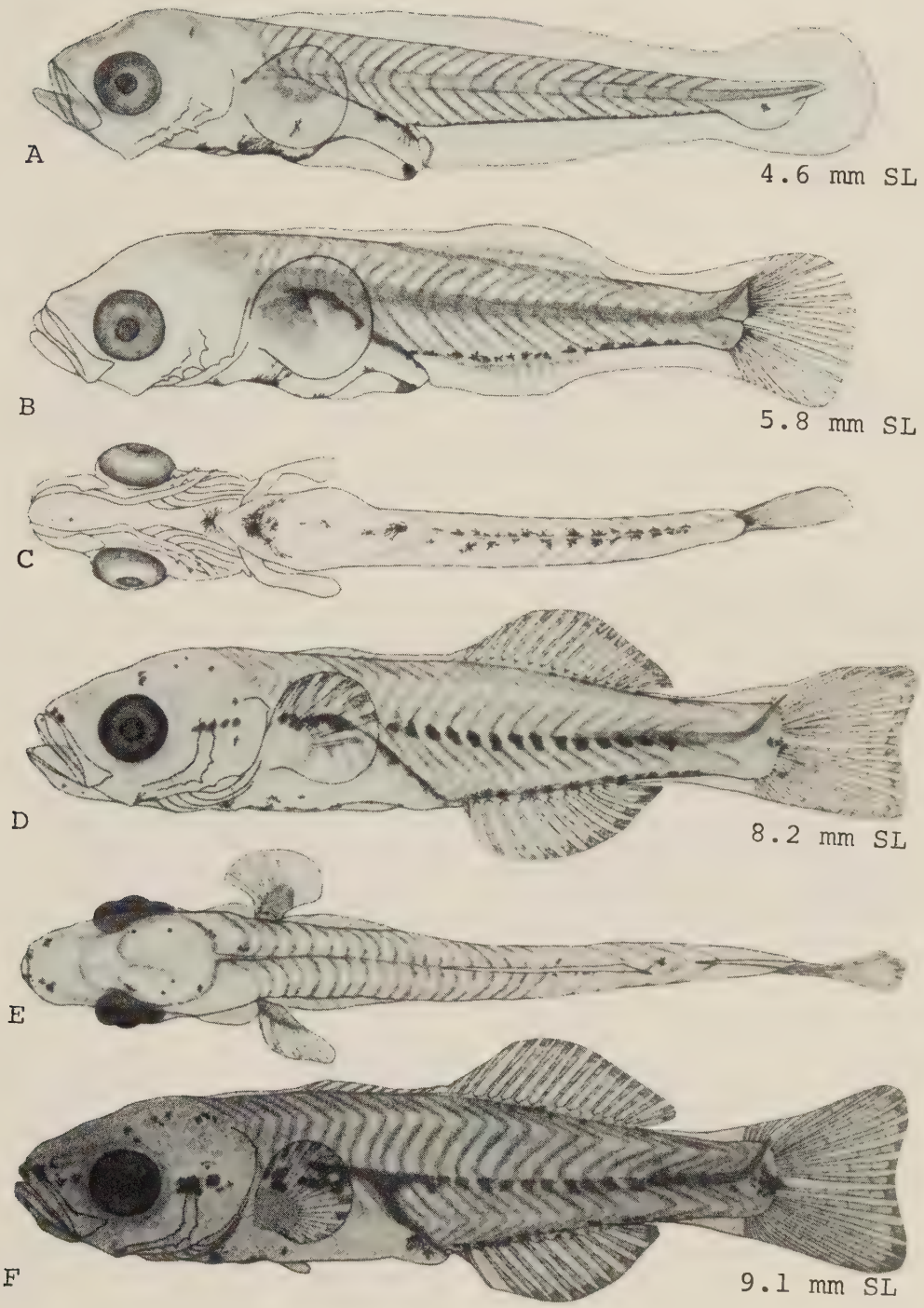

Fig. 91. *Haemulon plumieri,* White grunt. A. Larva, 6 days after hatching, 4.6 mm SL. B. Larva, 9 days after hatching, 5.8 mm SL. C. Ventral view of B. D. Larva, 12 days after hatching, 8.2 mm SL. E. Dorsal view of D. F. Larva, 13 days after hatching, 9.1 mm SL. (*A-F, Saksena, V. P., and W. J. Richards, 1975: figs. 4–7.*)

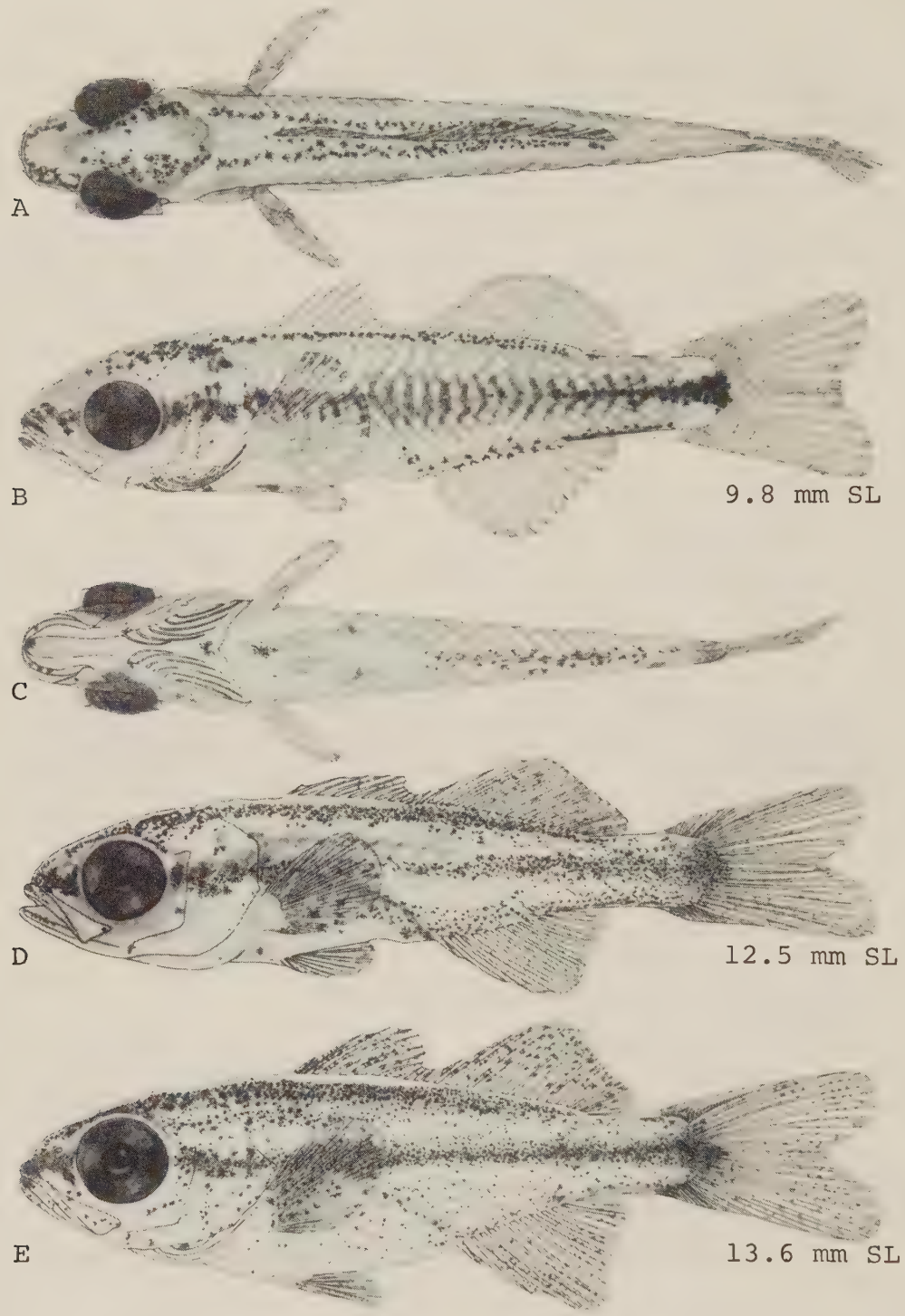

Fig. 92. *Haemulon plumieri*, White grunt. A. Juvenile, 18 days after hatching, 9.8 mm SL, dorsal view. B. Lateral view of A. C. Ventral view of A. D. Juvenile, 30 days after hatching, 12.5 mm SL. E. Juvenile, 40 days after hatching, 13.6 mm SL. (*A-E, Saksena, V. P., and W. J. Richards, 1975: figs. 8–10.*)

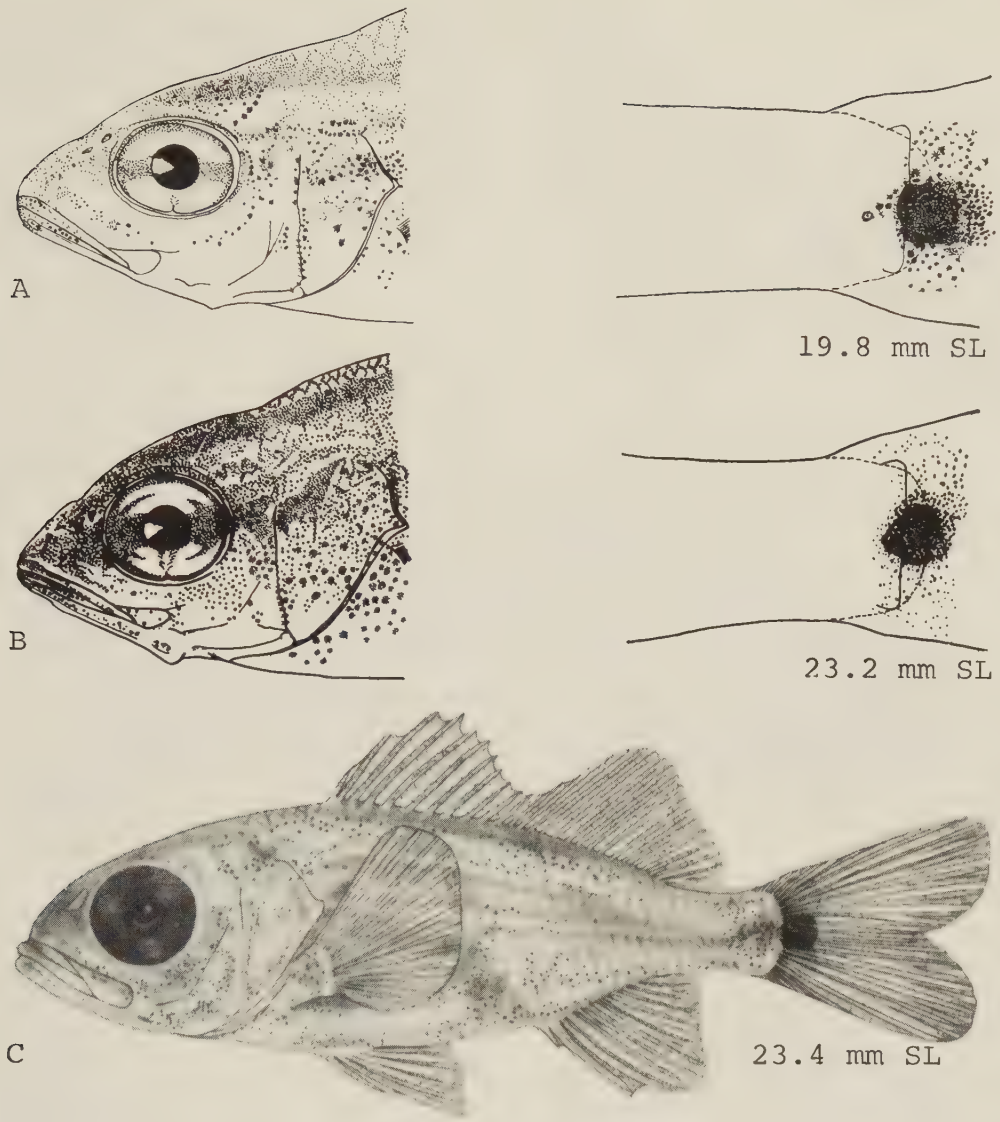

Fig. 93. *Haemulon plumieri*, White grunt. A. Juvenile, 19.8 mm SL, head and caudal region. B. Juvenile, 23.2 mm SL, head and caudal region. C. Juvenile, 102 days after hatching, 23.4 mm SL. (*A, B, Courtenay, W. R., Jr., 1961: fig. 12b-c. C, Saksena, V. P., and W. J. Richards, 1975: fig. 11.*)

anal elements present, but third anal spine develops tially as a segmented ray and is not fully transformed til 38.5 mm. By 7.8 mm full complement of principal udal rays present; by 7.9 mm procurrent rays begin to velop, full complement present by 12 mm. By 7.6–7.9 n pectoral rays evident, full complement present by mm. Pelvics appear as buds at 7.9 mm, spine devel- ed by 9.5 mm.[1]

eared and stained specimens: Middle dorsal and anal rygiophores acquire stain first and staining progresses eriorly and posteriorly at 5.9 mm, first anal pterygio- ore visible as cartilage; at 7.9 mm all dorsal and anal rygiophores developed as cartilage; predorsals first dent at 9.2 mm. At 5.8 mm supporting elements of caudal present as unstained cartilage; by 9.2 mm hypurals stained. At 4.6 mm little ossification evident, but outlines of most major osteological complexes visible and some, such as cleithrum, slightly stained; most bones discernible and showing evidence of stain uptake by 10 mm; at 8.2 mm pharyngeal tooth patches first appear; at 4.6 mm spination of preopercle first seen in 2 areas—an inner area with minute spines and the outer posterior margin which develops 3 large spines variably interspersed with smaller spines. At 4.6 mm notochord straight, neural spines faintly visible on vertebrae 5–12; at 5.8 mm all neural and haemal spines present as cartilage and some slight indication of vertebral segmentation evident; at 5.9 mm 10+25 vertebrae visible; at 9.2 mm vertebrae begin to stain.[1]

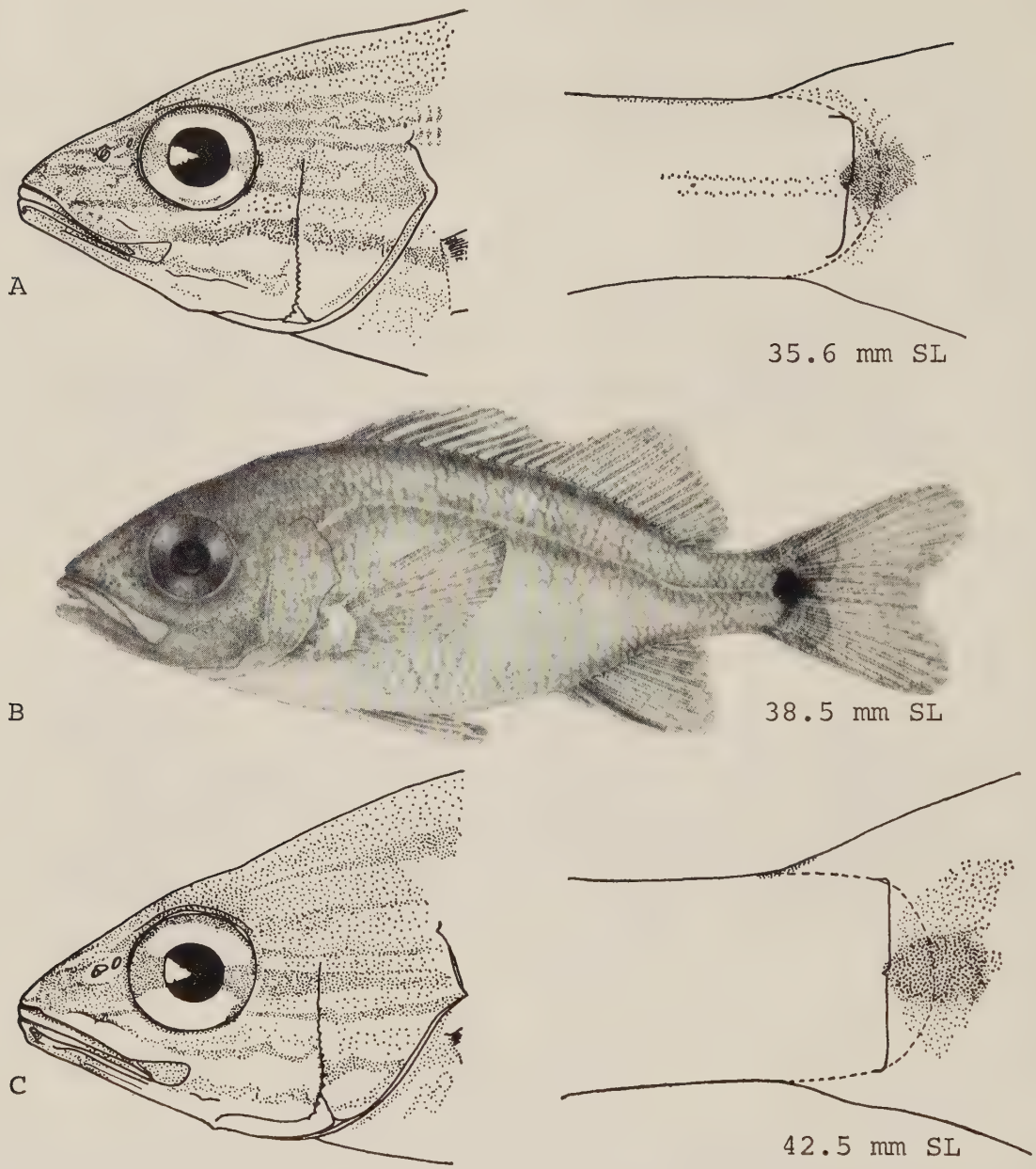

Fig. 94. *Haemulon plumieri*, White grunt. A. Juvenile, 35.6 mm SL, head and caudal region. B. Juvenile, 107 days after hatching, 38.5 mm SL. C. Juvenile, 42.5 mm SL, head and caudal region. (*A, C, Courtenay, W. R., Jr., 1961: fig. 12d, 13a. B, Saksena, V. P., and W. J. Richards, 1975: fig. 12.*)

nentation: At 3.7 mm, melanophores larger and more nerous but pigment absent from head; a few large ate melanophores on dorsal edge of gut, almost con- ous with a series of melanophores arranged along tral edge of myomeres; a small melanophore present ventral edge of notochord, near tip; several large ate melanophores scattered on ventral edge of gut; rge melanophore present on anterior edge of anus nding onto the finfold. At 4.6 mm posterior part of brain with a deeply embedded stellate melanophore. ween 8.2–9.1 mm melanophores more numerous; con- trations of pigment on snout, premaxillaries and low- aw; pigment on snout an extension of the midlateral pe of melanophores that began posterior to eye, ex- ding along trunk to end in a pigment spot on caudal uncle and fin; a series of large stellate melanophores erior to anus on ventral edge of body and some lar melanophores at base of second dorsal fin.[1]

VENILES

10 mm and larger.

ared and stained specimens: Pelvic bones fully devel- d and stained at 12.5 mm. Uroneurals stained by mm, epurals by 13 mm. Scapula and radials stained 9.8 mm, coracoid by 12.5 mm. At 12.5 mm vertebral mn well stained except for a few neural and haemal zygaphophyses. By 38.5 mm preopercular spination ced to serrations along margin. At 13.6 mm un- ed ctenoid scales visible along bases of soft dorsal anal fins and around caudal peduncle; at 23.4 mm stained scales on all areas except over gut and er side; by 38.5 mm scalation like that of adult.[1]

nentation: At 9.8–12.5 mm additional stellate melano- res appear dorsally, joining pigment on head with anophores under the second dorsal fin, to form a al body stripe. At 13.6 mm pigmentation increases ddition of scattered melanophores over entire body ace, including fins; dorsal and midlateral stripes more pronounced; a second series of melanophores extends from back of eye, posteriorly to end of first dorsal fin producing a body stripe between the dorsal and mid- lateral stripes. Between 23.4 and 38.5 mm, pigmentation less intense and no definite stripes present; melanophores generally scattered over body with no definite pattern, except for the prominent caudal spot.[1]

GROWTH

Most rapid during first 30 days; from 2.7 to 10.0 mm in 20 days, to 12.6 mm at 30 days; average daily growth about .32 mm/day; [1] average monthly growth of adults 1.4–3.6 mm.[12]

AGE AND SIZE AT MATURITY

No information.

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Orthopristis chrysoptera (Linnaeus), Pigfish

ADULTS

D. XII [5] to XIII, 15–17; A. III, 12–13; [3] C. 9+8, procurrent rays 12–13+11–12; [5] V. I, 5; [11] scales 71–77 in lateral series; [3] vertebrae 10+16; [5] gill rakers 12 on lower limb; [3] branchiostegals 7 (GDJ); teeth in jaws small, pointed, in broad bands; [3] no teeth on tongue, vomer, or palatines.[11]

Head 2.7–3.0, depth 2.3–2.7 in SL; snout 2.2–3.0, eye 3.6–5.0, maxillary 3.0–3.4, interorbital 3.9–4.7, pectoral fin 1.2–1.5 in head.[3]

Body elongate, compressed, back elevated; head moderate, snout long, tapering; mouth moderate,[3] maxillary slipping under lacrimal along most of its length.[11] Scales small, firm ctenoid, in oblique rows above lateral line and horizontal rows below it, extending onto base of caudal, pectoral, and pelvic fins, and forming a low sheath on base of dorsal and anal fins. Chin with a central groove behind symphysis.[18] Dorsal fin continuous, rather low, spines slender, pungent; caudal fin deeply concave, upper lobe longer.[3]

Pigmentation: Color in life light blue above, shading to silvery below; lacrimal and snout sky blue; a dash of blue on each side of upper lip; each scale on body with a blue center, the edge with a bronze spot, forming distinct orange-brown stripes on back and sides, those above the lateral line extending obliquely upward and backward, those below the lateral line nearly horizontal; snout with bronze spots; 1 or 2 cross lines connecting front of orbits; 2 or 3 oblique lines and numerous bronze spots on lacrimal; cheeks and opercles with distinct bronze spots; inside of mouth pale; inside of gill cavity tinged with golden; dorsal fin translucent with 3 rows of spots, margin dusky; caudal fin plain, yellowish at base, dusky toward tip; anal fin whitish, edge dusky, base bronze; pectoral and pelvic fins yellowish, the latter darker at tips. Fresh specimens without vertical bands. Preserved specimens silver-gray with faint streaks along scale rows; a distinct narrow dusky band from front of spinous dorsal through base of pectoral fins; behind this 7 or 8 cloudy, obscure bands, alternately broad and narrow; a horizontal dusky shade behind eye; spinous dorsal pale; soft dorsal with 3 rows of faint spots; other fins nearly plain.[18]

Maximum size: Reported to reach 380 mm.[7]

DISTRIBUTION AND ECOLOGY

Range: Bermuda and Massachusetts [8] to Mexico [3] and throughout the Gulf of Mexico; [8] uncommon north of Virginia.[10]

Area distribution: Southern Chesapeake Bay–Potomac River, Cape Charles, and Cape Henry, Virginia and Love Point, Maryland; [3] Isle of Wight Bay, Maryland; [13] Delaware Bay; [17] Atlantic, Cape May, Monmouth, and Ocean counties, New Jersey.[9]

Habitat and movements: Adults—most frequent over mud bottoms, occurring occasionally over sandy vegetated areas; [3] common in late July and August in Isle of Wight Bay, Maryland; [13] taken May through September in Virginia; [14] inhabits shore waters and estuaries of North Carolina throughout summer, arriving in March and April and disappearing again at the end of October and the first half of November; winter home not definitely known, but a few taken in 32 m about 20 miles offshore, so probably migrate offshore to more stable temperatures; [2] lower and middle reaches of estuaries in Georgia June to December; [20] taken all year in Gulf of Mexico but most abundant in November; [15] taken at Coral Gables every month except February but most abundant May through November. [12] Recorded from salinities of 0–44.1 ppt and temperatures of 13.7–36 C; [1] largest catches in the Gulf of Mexico at salinities above 29.0 ppt.[4]

Larvae—no information.

Juveniles—at Coral Gables taken during early part of year from channels and deep flats with sparse vegetation.[12]

SPAWNING

Location: Occurs at Beaufort along inside shores of Bogue and Shakleford Banks, also occurs with the harbor, in the estuaries, and on the outer shores of these banks.[2]

Season: Probably begins at Beaufort as early as middle of March and ends near latter part of June with a peak in May; [2] occurs in spring in Chesapeake Bay [3] and Texas,[15] and apparently somewhat earlier in Florida, as 40 mm juveniles are present by June.[6]

Time: Takes place in early evening, mostly between 1800 and 2000 hours.[2,16]

EGGS

Buoyant, float with oil globule uppermost; highly transparent; spherical, .7–.8 mm in diameter; 1 oil globule (occasionally 2, rarely 3), average .16 mm in diameter, occupying the pole opposite blastodisc. Easily confused with egg of *Bairdiella chrysoura* and eggs of both species are taken in same areas during greater part of spawning season of *O. chrysoptera;* distinguishing characteristics as follows—1) oil globule of *B. chrysoura* not as clear. 2) *B. chrysoura* acquires dark greenish specks in advanced cleavage stage which increase in number and persist for 24 hours after hatching whereas in *O. chrysoptera,* if

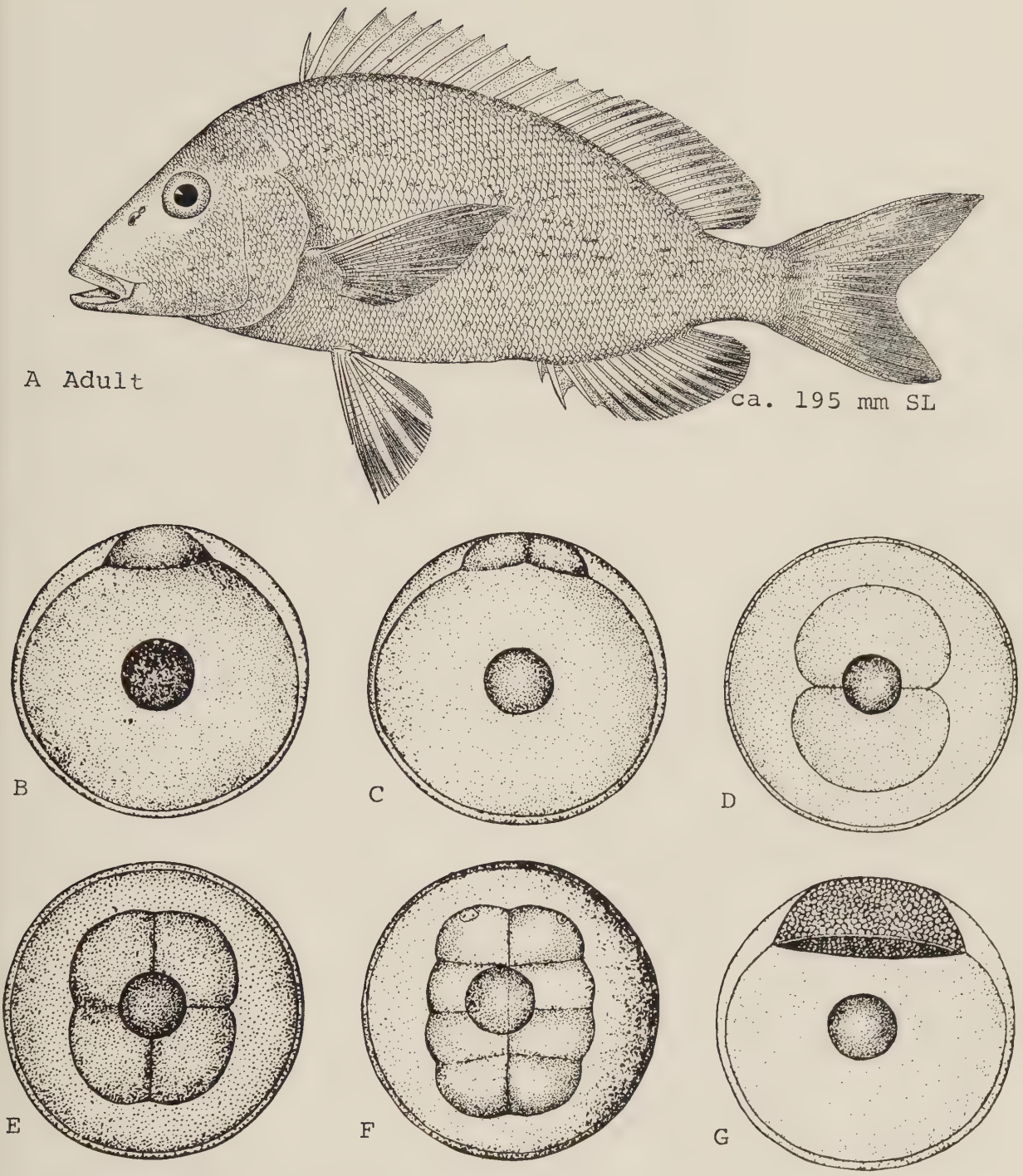

Fig. 95. *Orthopristis chrysoptera*, Pigfish. A. Adult, ca. 195 mm SL. B. Egg with fully developed blastodisc, a few minutes after fertilization, ca. .75 mm in diameter. C. Egg in 2-cell stage, ca. 30 minutes after fertilization. D. Dorsal view of C. E. Egg in 4-cell stage, ca. 45 minutes after fertilization, dorsal view. F. Egg in 8-cell stage, ca. 1 hour after fertilization, dorsal view. G. Egg in late cleavage stage. (*A, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 541. B-G, Hildebrand, S. F., and L. E. Cable, 1930: figs. 16–21.*)

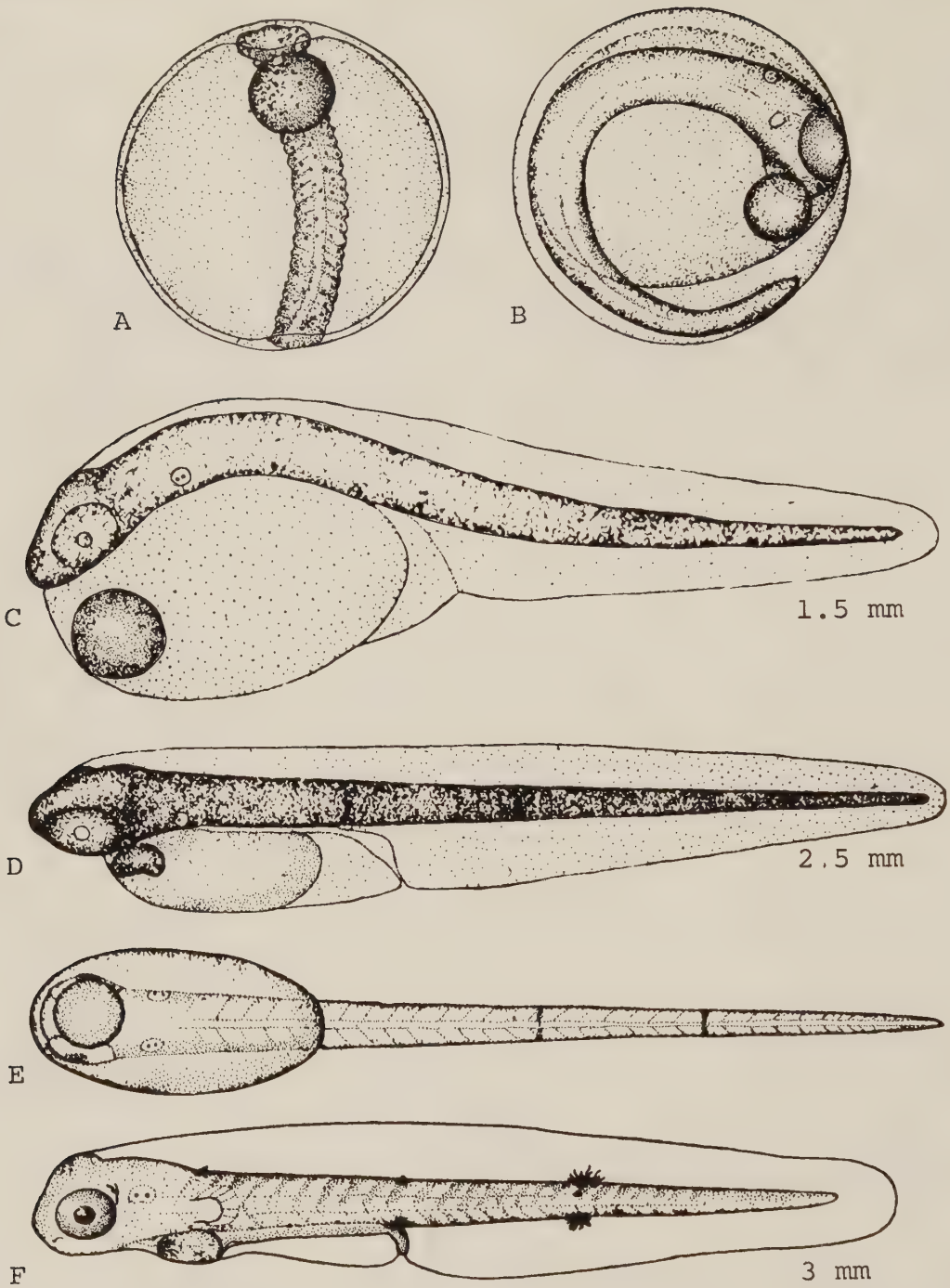

Fig. 96. *Orthopristis chrysoptera*, Pigfish. A. Egg with developing embryo showing distribution of chromatophores, ca. 24 hours after fertilization. B. Egg with well developed embryo, ca. 36 hours after fertilization. C. Yolk-sac larva, newly hatched, 1.5 mm. D. Yolk-sac larva, 1 day after hatching, 2.5 mm. E. Ventral view of D. F. Yolk-sac larva, 2.5 days after hatching, 3 mm. (*Hildebrand, S. F., and L. E. Cable, 1930: figs. 22–27.*)

dark specks appear they are gone by embryonic stage. 3) oil globule lies under or near ventral surface of head in *O. chrysoptera* as opposed to well behind head in *B. chrysoura*.[2]

EGG DEVELOPMENT

At 19.4–20 C eggs reach 2-cell stage within 30 minutes after fertilization, the 4-cell stage within 45 minutes [2,16] and an advanced cleavage stage within 6 hours; after 12

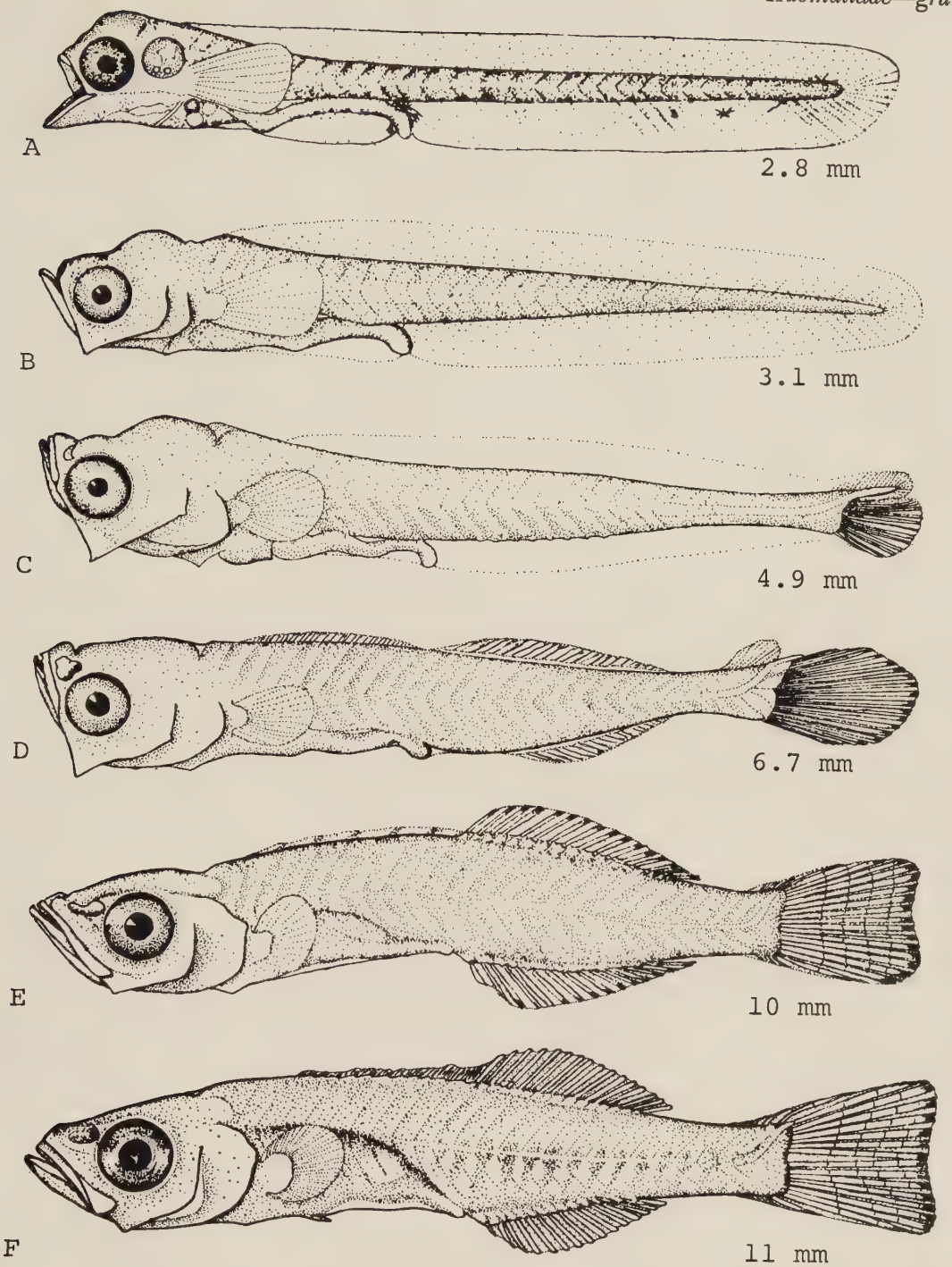

Fig. 97. *Orthopristis chrysoptera,* Pigfish. A. Larva, 2.8 mm. B. Larva, 3.1 mm. C. Larva, 4.9 mm. D. Larva, 6.7 mm. E. Larva, 10 mm. F. Larva, 11 mm. (*Hildebrand, S. F., and L. E. Cable, 1930: figs. 28–33.*)

urs germ ring often visible, after 24 hours embryo well med, and after 36 hours some begin to hatch. Mode segmentation: blastodisc becomes somewhat elongate t before first cleavage and is then cut at right angles longer axis; second cleavage plane cuts first at right gles.[2]

Incubation period: At temperatures prevailing in North Carolina waters during spawning season (16–29 C), probably ranges from 36–72 hours, the shorter period being late in the season when temperatures are high and the longer period early when temperatures are low.[2]

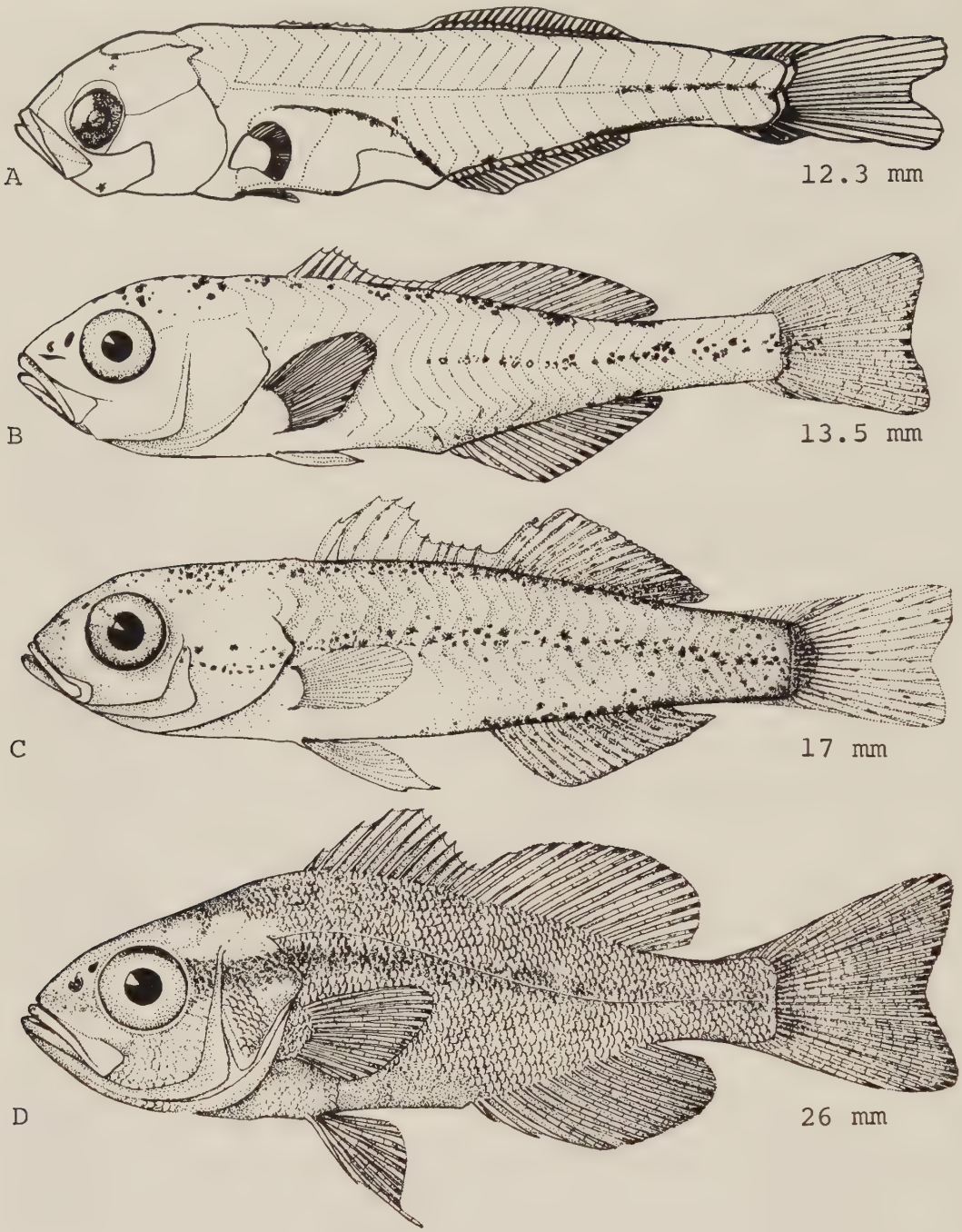

Fig. 98. *Orthopristis chrysoptera,* Pigfish. A. Larva, 12.3 mm. B. Larva, 13.5 mm. C. Larva, 17 mm. D. Juvenile, 26 mm. (*A, de Sylva, D. P.,* et al., *1973: p. 130. B-D, Hildebrand, S. F., and L. E. Cable, 1930: figs. 34–36.*)

YOLK-SAC LARVAE

Hatches at about 1.5 mm.

Floats on back until most of yolk absorbed and pectoral fin evident at about 2.8 mm; at hatching head deflected downward; body straight by 2.5 mm.[2]

Pigmentation: At hatching, a few greenish spots on dorsal surface of head and body placed as follows: a few indistinct ones over snout, a few larger ones just behind head, and a pair a short distance behind auditory canals; an additional pair of spots above posterior portion of yolk sac, 2 over vent, and 2 more at mid-caudal length; from certain angle, pigment spots give appearance of crossbars. Oil globule slightly greenish, occasionally with a few darker spots. At 2.5 mm anterior pigment spots dif-

use but spots over vent and at mid-caudal length quite listinct, forming more or less definite crossbars; spots ehind auditory canal persisting in some.[2]

eparable from *Bairdiella chrysoura* by having fewer and ess prominent pigment spots.

ARVAE

.1–25 mm.

t 3.1 mm body elongate, anus well in advance of mid-ody, mouth almost vertical; at 10 mm body compressed nd deeper, depth about 6 in SL, mouth less vertical; at 1 mm depth about 5.3 in SL; at 15 mm body notably ompressed, depth about 4.2 in SL. At 6.7 mm dorsal nd anal fins becoming differentiated but without definite ays; at 10 mm soft dorsal and anal fins developed; at 11 mm a few dorsal spines evident; at 15 mm about 7 dorsal spines present well in advance of and separate from soft dorsal; at 17 mm about 10 dorsal spines and a few rudiments present, the spinous portion now continuous with the soft. At 4.9 mm caudal fin partly differentiated, a few rays evident ventrally; at 6.7 mm caudal fin better developed with a rounded margin; by 10 mm caudal fin well formed, somewhat emarginate. Pelvic fins first appear at 11 mm. Notochord straight at 3.1 mm, curved upward slightly at 4.9 mm, and completely flexed by 10 mm.[2]

Pigmentation: At 3.1 pigment spots absent in preserved specimens. At 10 mm pigmentation becoming evident in darkened margins of opercle and preopercle, distal ends of fin rays, and the broken black crosslines on caudal fin. At 15 mm a dark mid-lateral band present; lips and snout dusky; small areas of chromatophores present on head

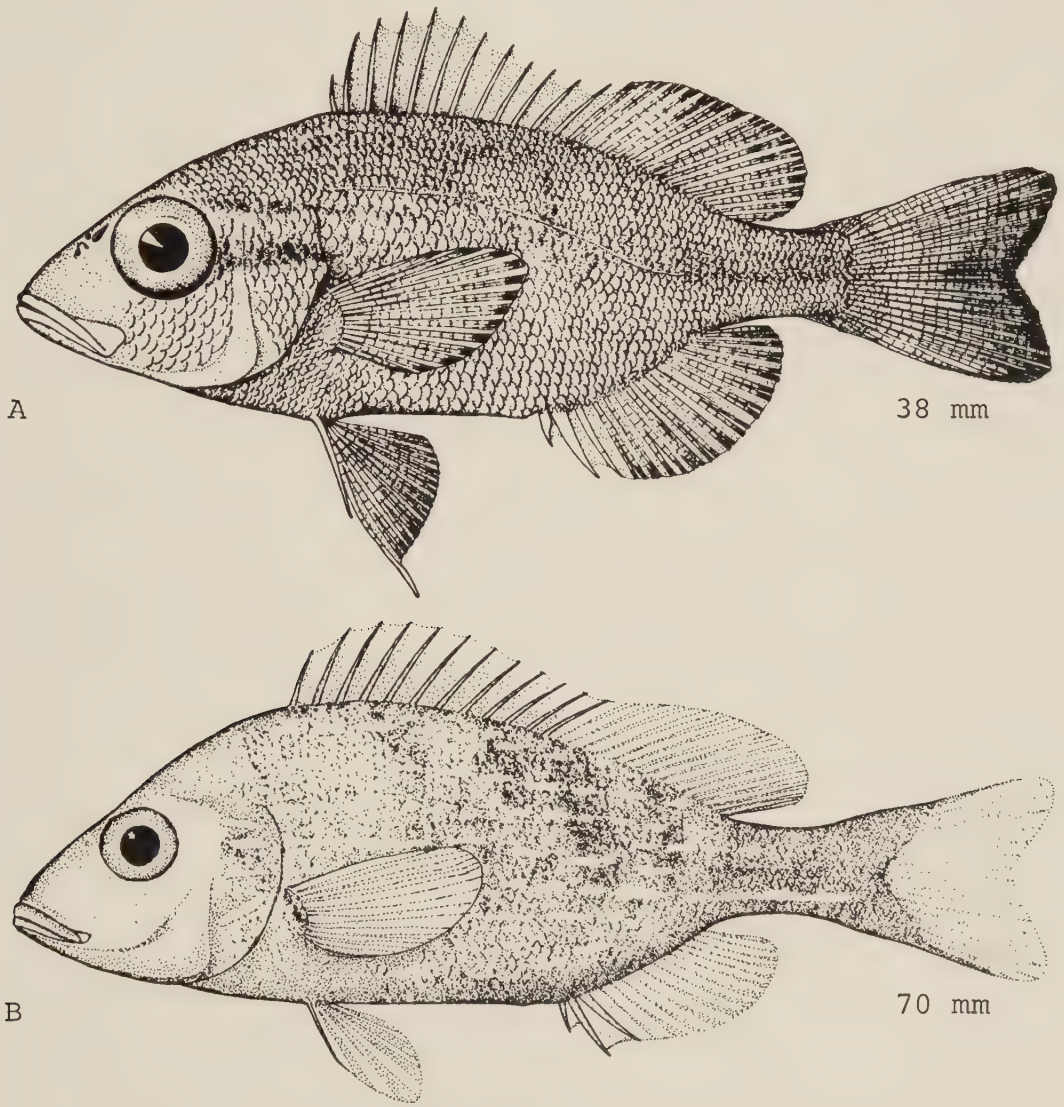

Fig. 99. *Orthopristis chrysoptera,* Pigfish. A. Juvenile, 38 mm. B. Juvenile, 70 mm. (*Hildebrand, S. F., and L. E. Cable, 1930: figs. 37–38.*)

and back, scattered dusky dots present along base of anal fin. At 17 mm dark mid-lateral band quite prominent.[2]

JUVENILES

About 25 mm and larger.

At 25 mm body depth about 3.0 in SL, mouth oblique as in adult; at 40 mm body more strongly compressed, back narrow and high as in adult, depth about 2.8 in SL; by 70 mm form essentially that of adult, back strongly elevated, anterior ventral outline nearly straight, snout pointed, depth about 2.4 in SL. At 25 mm 13 dorsal spines present, shape of fin approaching that of adult. At 25 mm body fully scaled with strongly ctenoid scales.[2]

Pigmentation: At 25 mm dark mid-lateral band prominent; an additional dark band present from nape to base of second dorsal fin. At 40 mm lateral bands often absent, anterior portion of lower band remaining longer; indications of dark crossbars sometimes present; in life yellow and green horizontal lines present on sides, being most prominent on cheeks and opercles. By 70 mm color pattern similar to that of adult.[2]

GROWTH

Average sizes at Beaufort, North Carolina: March, 5 mm; April, 6 mm; May, 5 mm; June, 18 mm; July, 17 mm; August, 86 mm; September, 106 mm; October, 117 mm. Earlier and faster growing young may reach a length as great as 157 mm by end of first year, whereas the later and smaller young of the same season reach only 87 mm.[2]

AGE AND SIZE AT MATURITY

Mature in second year,[2,19] after which most may die; [19] few reach 3 years and very few 4 years.[2,19] Smallest mature specimens 200–215 mm.[2]

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Bairdiella chrysoura
Cynoscion nebulosus
Cynoscion nothus
Cynoscion regalis
Larimus fasciatus
Leiostomus xanthurus
Menticirrhus americanus
Menticirrhus littoralis
Menticirrhus saxatilis
Micropogonias undulatus
Pogonias cromis
Sciaenops ocellata
Stellifer lanceolatus

drums
Sciaenidae

FAMILY SCIAENIDAE

The sciaenids are primarily bottom associated, carnivorous fishes distributed worldwide in tropical and temperate inshore waters. The majority occur on open sand and mud bottoms and some are found only in brackish waters. The exact number of species is uncertain, but there are probably between 150 and 200. Chao (1976) recently revised the sciaenids of the western Atlantic and found that they comprise 56 species in 21 genera. Thirteen species in nine genera are known to occur in the Chesapeake Bay region.

Most sciaenids are capable of producing sounds and this has resulted in the common name croaker or drum. These sounds are produced by the action of special muscles which insert on the wall of the swimbladder. Little is known of the reproductive behavior of sciaenids, but it is believed that sound production may be associated with spawning. Species of the genus *Menticirrhus* lack a swimbladder and do not produce sounds.

Croakers are characterized by a generalized percoid body form with a deeply notched or completely separated dorsal fin and only one or two (usually two) anal spines. Other significant characters are as follows: lateral line extending to end of caudal fin; chin typically with enlarged pores; skull typically cavernous (cephalic sensory canals enlarged); pelvic fins I, 5; pelvic axillary process well developed; palatines and vomer endentulous; branchiostegals 7; subocular shelf present on second suborbital; supramaxillary absent; vertebral number variable, usual total 25; principal caudal rays 9 + 8; caudal with two uroneurals and three epurals; procurrent spur usually present, absent in some (GDJ).

All known sciaenid eggs share the following characteristics: pelagic; small, diameter .66 to 1.3 mm; usually multiple oil globules which coalesce and become pigmented with development. These characteristics are useful in identifying eggs as sciaenid, but eggs of the following non-sciaenid species may be confused with them: *Orthopristis chrysoptera, Scomber scombrus, Stenotomus chrysops,* and *Peprilus triacanthus* (similar to weakfish eggs). Identification of sciaenid eggs to species is even more difficult, as many are morphologically quite similar and spawning seasons and areas often overlap (Joseph, 1964; Lippson and Moran, 1974).

Sciaenid larvae are characterized by a short, deep, robust head; a body which tapers sharply to a point posteriorly; short gut; large oblique mouth; large eye; absorption of yolk usually within 1 mm after hatching (Lippson and Moran, 1974). Hildebrand and Cable (1934) presented a key to some eggs and larvae and all juveniles of the 13 species considered here. Although the knowledgeable student of ichthyoplankton may find it a useful guide, it must be used with caution as it contains a number of inaccuracies. Unfortunately, understanding of the development of these species is still inadequate to allow preparation of a meaningful operational key to complete life history stages. The table on page 210 of Lippson and Moran (1976) provides comparative spawning information and significant characteristics of the eggs, larvae, juveniles and adults of nine sciaenid species. This should be useful when used in conjunction with the updated information presented in the species accounts in this volume.

*Bairdiella chrysoura** (Lacépède), Silver perch

ADULTS

D. XI [27] to XII,[6,8,27] 19 [8,27]–23; [2,6] A. II,[2,8,27] 8 [6,8]–10; [6,8,27] C. 9+8, procurrent rays 8–9+5–8; [8] P. 15–17; [6] V. I, 5; [30] lateral line scales 47–53, circumferential caudal peduncle scales 23–25; vertebrae variously given as 12+13,[6] 11+14,[8] and 10+15; [2] total gill rakers 22–24; [6] teeth conical, in narrow bands, those in the outer row in upper jaw and the medial row in lower jaw slightly enlarged (LNC); no teeth on vomer, palatines or tongue.[28]

Head 2.8–3.4, depth 2.8 [27]–3.3; [28] snout 3.7 [27]–4.2,[28] eye 2.8 [27]–4.2,[28] maxillary 1.9 [27]–2.4,[28] interorbital 3.7–4.1.[27]

Body oblong, compressed; back moderately elevated,[27] profile slightly depressed over eyes; [28] head moderately large; snout conical,[27] as long as eye; [28] mouth a little oblique, terminal; maxillary reaching to posterior margin of pupil. Scales moderate, rather firm, ctenoid,[27] those on head cycloid; [28] small scales covering most of soft dorsal, caudal, anal, and bases of pectoral and pelvic fins. Dorsal fin continuous with a deep notch in between the spinous and soft portions; dorsal spines slender, the third or fourth longest; [27] caudal fin convex to truncate (LNC); pectoral fin short, not reaching tip of pelvic fin. Preopercular margin strongly serrate, spines at angle somewhat enlarged,[27] the lowest and largest directed downward.[28]

Pigmentation: Olivaceous, greenish or bluish gray above; lower part of sides and abdomen bright silvery; [27] back and sides more or less densely punctulate with dark dots (especially in northern specimens), these forming narrow, somewhat irregular streaks along sides; [28] pectoral, pelvic, anal and caudal fins mostly yellowish; dorsal, caudal, and sometimes tip of anal fin partly dusky.[27]

Readily recognized by relatively plain coloration, pelvic, anal and caudal fins yellowish, rather deep and compressed body, oblique, terminal mouth, and serrated preopercular margin.[27]

Maximum size: Seldom exceeds 240 mm.[5]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic and Gulf of Maine from Massachusetts to Texas, very abundant from New Jersey to North Carolina.[24]

Area distribution: Chesapeake Bay, widespread in Maryland and Virginia, rare north of Annapolis; [27] ocean coasts of Maryland [18] and Virginia; [23] Delaware; [12] Atlantic, Cape May, Middlesex, Monmouth, and Ocean counties, New Jersey.[9]

Habitat and movements: Adults—most common in bays and quiet lagoons, especially around estuaries,[22] over mud and sand bottoms.[6] Move to deeper bay waters and offshore waters in winter, returning in spring to spawn.[13,22] Taken in bays near Ocean City, Maryland May–September; [18] taken in Chesapeake Bay April–November, most abundant in September and October; [27] taken on eastern shore of Virginia May–October; [23] most common at Cedar Key, Florida May–November.[15] Euryhaline,[13,22] taken in salinities from 0–48 ppt; taken at temperatures from 10–34.5 C.[3]

Larvae—taken in salinities from 2 [11]–37.4 ppt and temperatures from 16.4–31.8 C.[4]

Juveniles—generally taken along shore zone of rivers, in ditches and in lower portions of marsh creeks over mud or mud-sand bottom,[12] often in very turbid water and heavy detritus.[24] In York River, Va., young of year, when first entering estuary (May–June) tend to stay in shoal area of rivers (not in shallow beach zone) move to deeper (channel) water as the fish grow (September to November) (LNC). At Beaufort, remain in shallow grassy areas during first summer,[24] the majority moving to deeper water during the winter.[24,26] Taken in salinities from 0 [12]–35 ppt [20] and temperatures from 4.8 [12]–32.5 C.[20]

SPAWNING

Location: Probably occurs primarily in bays,[12,13,20,24] but perhaps to some extent offshore, as eggs have been taken off North Carolina as far as 19–24 km from shore.[24]

Season: Occurs in New Jersey June–August with a peak in June; [5] Delaware Bay peak in early June, followed by a smaller spawning in late July; [12] late spring and early summer (May–July [7]) in Chesapeake Bay; [27] April to mid-July in North Carolina, with a peak last half of May to early June; [24] apparently some spawning year round in Everglades, with a peak probably in late January or early February; [4] May–September in northern Florida,[15] similar in Texas and Louisiana.[13]

Temperature and salinity: Ripe individuals or eggs taken in salinities from 14.3 [13]–26 ppt [12] and temperatures from 19.4 [17]–28 C.[1]

Time: In North Carolina apparently always occurs at about 2000 hours.[1]

Fecundity: 52,000 eggs at 140 mm.[27]

EGGS

Pelagic; spherical; almost perfectly transparent after differentiation of blastodisc; [1] reported range of total diameters 0.66–0.88 (mean 0.69–0.83 mm [7]); membrane thin

*The spelling of *chrysoura* as *chrysura* was an error initiated by Jordan and Eigenmann, 1889 and perpetuated in the literature. The correct spelling is *chrysoura* (Lacépède, 1802).[30]

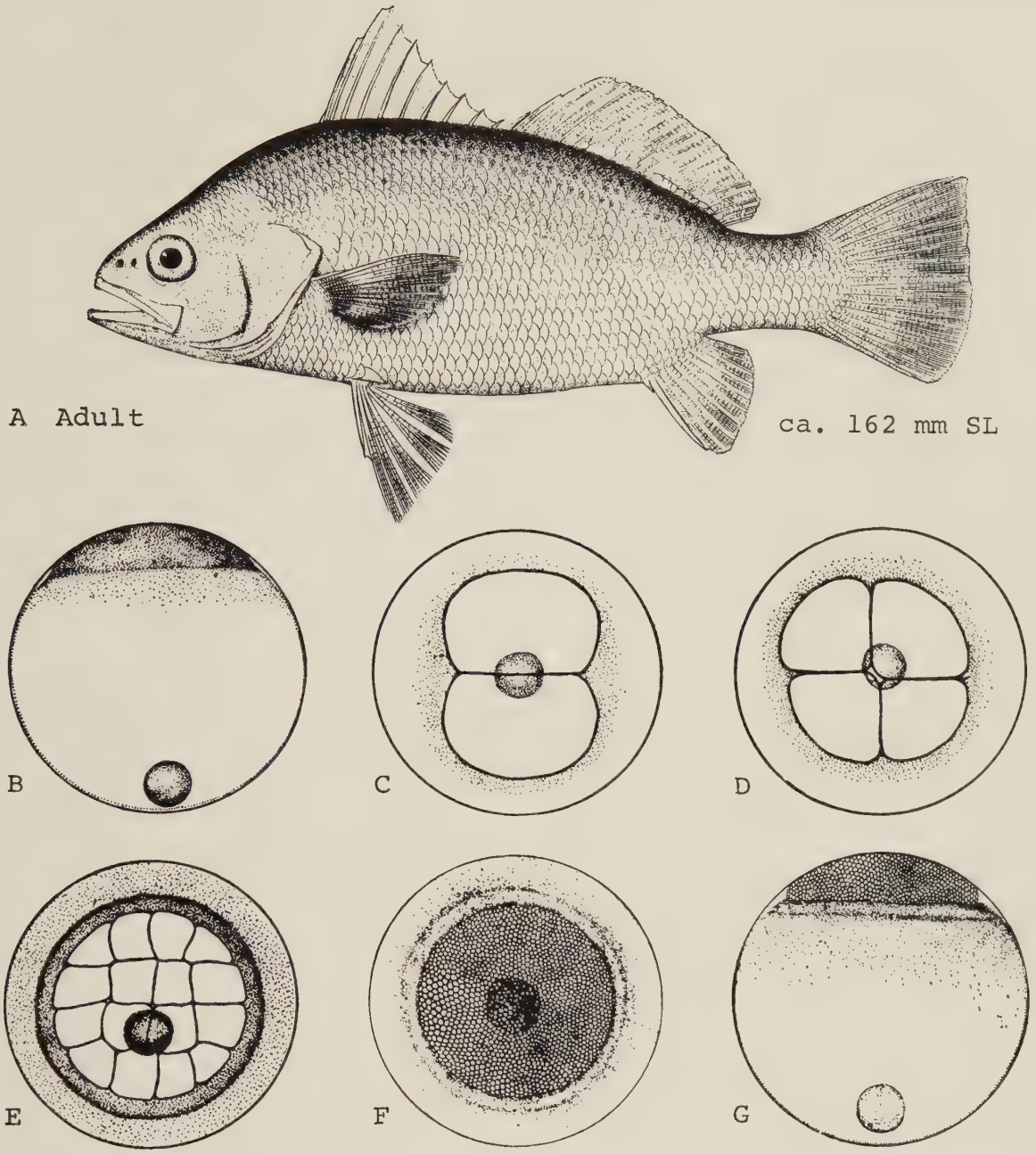

Fig. 100. *Bairdiella chrysoura,* Silver perch. A. Adult, ca. 162 mm SL. B-G. Eggs in early stages of development. (*A, Goode, G. B., 1884: pl. 126. B-G, Kuntz, A., 1915: figs. 1–6.*)

ıd horny; [1] 1–2 oil globules,[7] 0.16 [5]–0.22 mm in diameter, ɔarsely pigmented; [7] oil globule located near upper ɔle of yolk sac; perivitelline space very narrow.[1] Similar eggs of *Orthopristis chrysoptera* [24] (which see for stinction).

GG DEVELOPMENT

fter fertilization, layer of protoplasm over yolk sac ecomes concentrated at pole opposite oil globule, forming a lenticular cap on surface of yolk, the blastodisc; fully developed blastodisc circular, its periphery fading away imperceptibly into a very thin layer of protoplasm on surface of yolk sac; a small amount of protoplasm in vicinity of oil globule becoming concentrated to form a protoplasmic cap covering about a third of surface of oil globule. Cleavage generally very regular; first plane of cleavage cuts blastodisc at right angles to longer axis of blastodisc; second cleavage plane cuts first at right angles; first 4 blastomeres usually quite symmetrical and

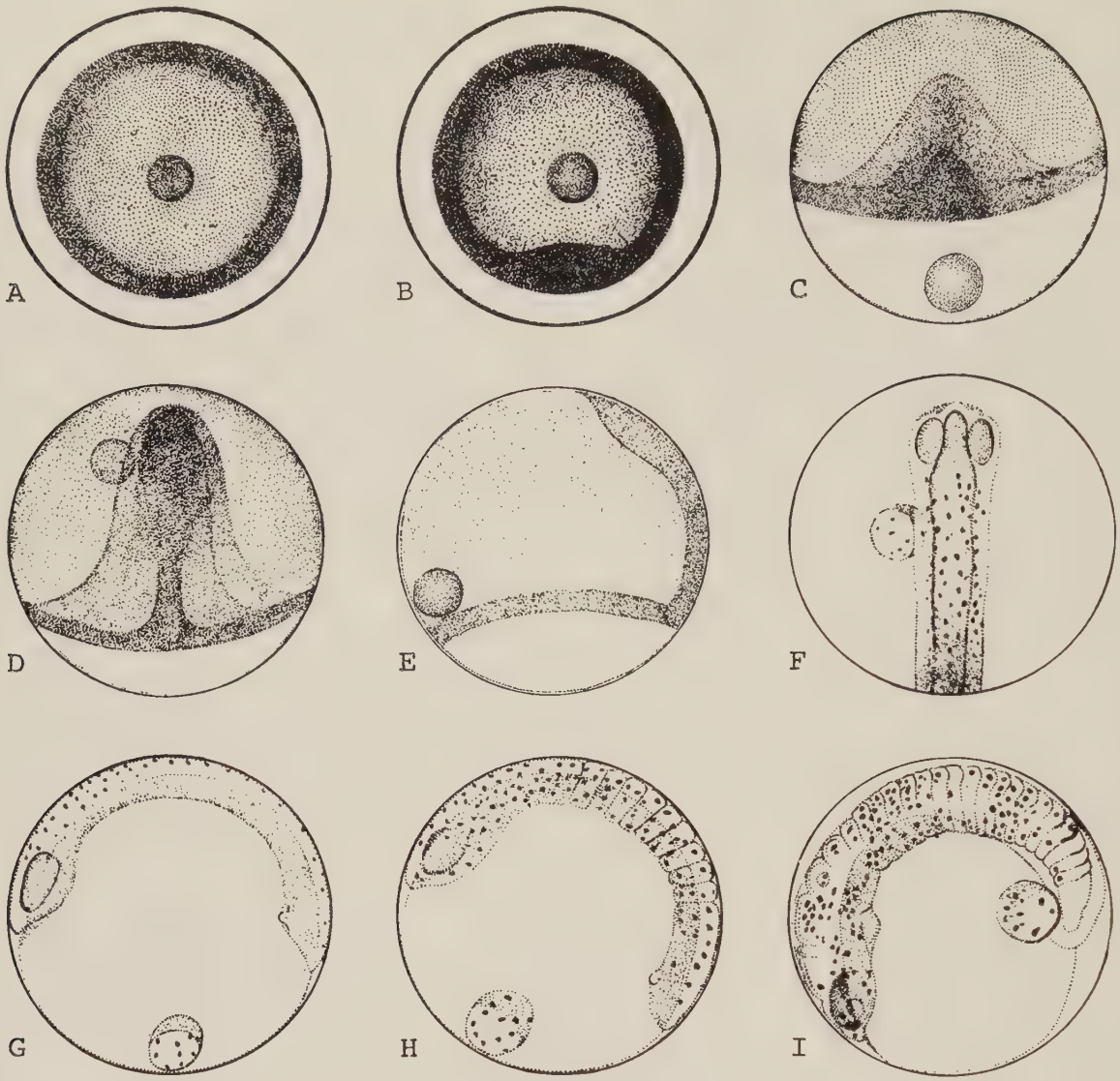

Fig. 101. *Bairdiella chrysoura,* Silver perch. A. Egg with blastoderm showing early germ ring. B. Egg with blastoderm showing fully developed germ ring and beginning of embryonic shield. C-D. Eggs showing later stages in differentiation of embryonic shield. E. Lateral view of egg shown in D. F. Early embryo showing distribution of chromatophores. G. Lateral view of egg shown in F. H. Egg with embryo showing 10 myomeres. I. Egg with advanced embryo. (*A-I, Kuntz, A., 1915: figs. 7–15.*)

approximately equal in size; in 4-cell stage 2 axes of blastoderm approximately equal; third cleavage furrows cut blastoderm approximately parallel with first; at completion of third cleavage, blastoderm composed of 8 cells, one axis distinctly longer than other; at 16-cell stage, blastoderm usually more or less circular; regularity of cleavage still evident in blastoderm of 64 cells. During early cleavage marginal cells of blastoderm continuous with thin layer of protoplasm on surface of yolk sac; this layer concentrated at periphery of blastoderm to form low ridge which gives rise to periblast; as segmentation advances, nuclei appear in periblast; cells at margin of blastoderm gradually become more definitely limited peripherally until completely cut off from periblast, at which time blastoderm somewhat dome shaped with a perceptible cleavage cavity beneath its central area; periblast gradually becomes wider and more distinct and sends a thin sheet of protoplasm centripetally beneath cleavage cavity. As marginal cells are becoming cut off from periblast a thickening (representing an early stage in differentiation of germ ring) appears at periphery of blastoderm caused primarily by thinning of central area of blastoderm and secondarily by invagination of marginal cells; as germ ring differentiates, cells forming surface layer of blastoderm become thin and flattened; when germ ring completely differentiated,

lastoderm increases in size more rapidly as does broad ngue of cells growing into subgerminal cavity from mbryonic pole of germ ring; area of blastoderm over growing tongue of cells becomes differentiated, repre-enting an early stage in formation of embryonic shield. fter embryonic shield distinctly outlined there occurs thickening along anteroposterior axis, representing the xis of the future embryo; differentiation of embryonic xis begins in head region and gradually proceeds pos-eriorly to posterior pole of blastoderm; when embryonic xis well differentiated, blastoderm covers more than hree-fourths of yolk surface. Further differentiation of mbryo advances very rapidly and germ ring continues advance around yolk until blastoderm covers entire rface of yolk sac and blastopore is completely closed hours after fertilization at ca. 27 C); posterior pole blastoderm remains in a relatively fixed position. At me of blastopore closure, embryo extends about half-ay around yolk sac, and no pigment evident on egg or mbryo. Within 1.5–2 hours after blastopore closure at a. 27 C, yellow chromatophores sparsely distributed ver dorsal and dorsolateral aspects of embryo and a ew also apparent on oil globule; Kupffer's vesicle pres-nt as a small bubble-like body on ventral surface near osterior end of embryo. An hour later chromatophores ore numerous and distributed more or less uniformly ver entire dorsal and lateral surfaces of embryo; Kupf-r's vesicle fully developed (from this point, gradually ecreases in size until it disappears); length of embryo xceeds half circumference of yolk sac and shows 10–12 yomeres. As hatching approaches, distribution of hromatophores undergoes a material change; a few ours before hatching posterior portion of body free om yolk sac and narrow finfolds apparent.[1]

ime to hatching ca. 18 hours at ca. 27 C,[1] 40–50 hours 19–21 C.[5]

OLK-SAC LARVAE

atch at 1.5–1.9 mm.[5]

ollowing description based on fresh material.

igmentation: At hatching body brownish yellow,[1] arked by 5 vertical bands of yellow chromatophores, ne on head, one behind head, one in front of anus, and on caudal portion of body; [5] a few scattered chromato-hores occur between the bands; finfolds and posterior p of body transparent. Five hours after hatching ver-cal bands broken up; a distinct vertical yellow band mains about two-third distance from anus to posterior nd of body and an additional one occurs just behind ead; groups of scattered chromatophores occur in head gion and above vent; a few more or less isolated hromatophores occur also on posterior half of body. ne day after hatching (2.4–2.6 mm) general body color ill brownish yellow; finfolds and posterior one-fifth of body still transparent; yellow chromatophores fewer; posterior vertical band now consists of a dorsal and ventral group of chromatophores; no distinct vertical band in anterior region, but a few yellow chromato-phores remain scattered over head and anterior trunk region.[1]

LARVAE

Specimens described 2.5–9 mm.

Following description based mainly on unpreserved material.

Two days after hatching (2.5–2.8 mm) yolk completely absorbed.[1,5] At 3.5–5 mm notochord beginning to flex; flexion completed by 7–8 mm.[1] At about 7 mm dorsal fin rays beginning to develop. At about 9 mm anal fin rays beginning to develop.[12] In formalin preserved specimens notochord flexion occurs at 3.8–4.8 mm SL and dorsal and anal rays first appear at 4.3 mm in SL and are complete by 4.8–5.0 mm SL (HWP).

Pigmentation: At 2.5–2.8 mm general color of body light brownish yellow, marked by 2 distinct vertical bands, the first located just behind head and composed of yellow chromatophores on a blackish band (appearing black), the second located about two-thirds distance from anus to posterior end of body and composed of dorsal and ventral groups of yellow chromatophores on a diffuse blackish background (appearing yellowish); yellow chromatophores no longer present on other parts of body; finfold and posterior end of body transparent. At 3.5 mm general color of body somewhat lighter; both vertical bands distinctly blackish; yellow pigment still present in vertical bands, but obscured by denser blackish background; from anterior blackish band, 2 blackish bands extend anteroventrally, one terminating near eye, the other extending diagonally over preopercle and cheek; posterior vertical band discontinuous, composed of dorsal and ventral pigmented areas; several blackish pigment spots present along ventral margin of body between anus and posterior vertical band. At 5 mm general body color silvery gray; anterior vertical band and dorsal and ventral remnants of posterior band distinctly blackish; a small darkish area present dorsally opposite anus; several small darkly pigmented areas present along ventral margin of body posterior to anus. At 8–9 mm anterior vertical band and other darkly pigmented areas begin to disappear.[1]

Readily recognized by 2 vertical bands, first behind head and second less pronounced, about two-thirds distance from anus to tip of tail.[25] In preserved material, second band may be represented only by a large melanophore at posterior end of anal base (HWP).

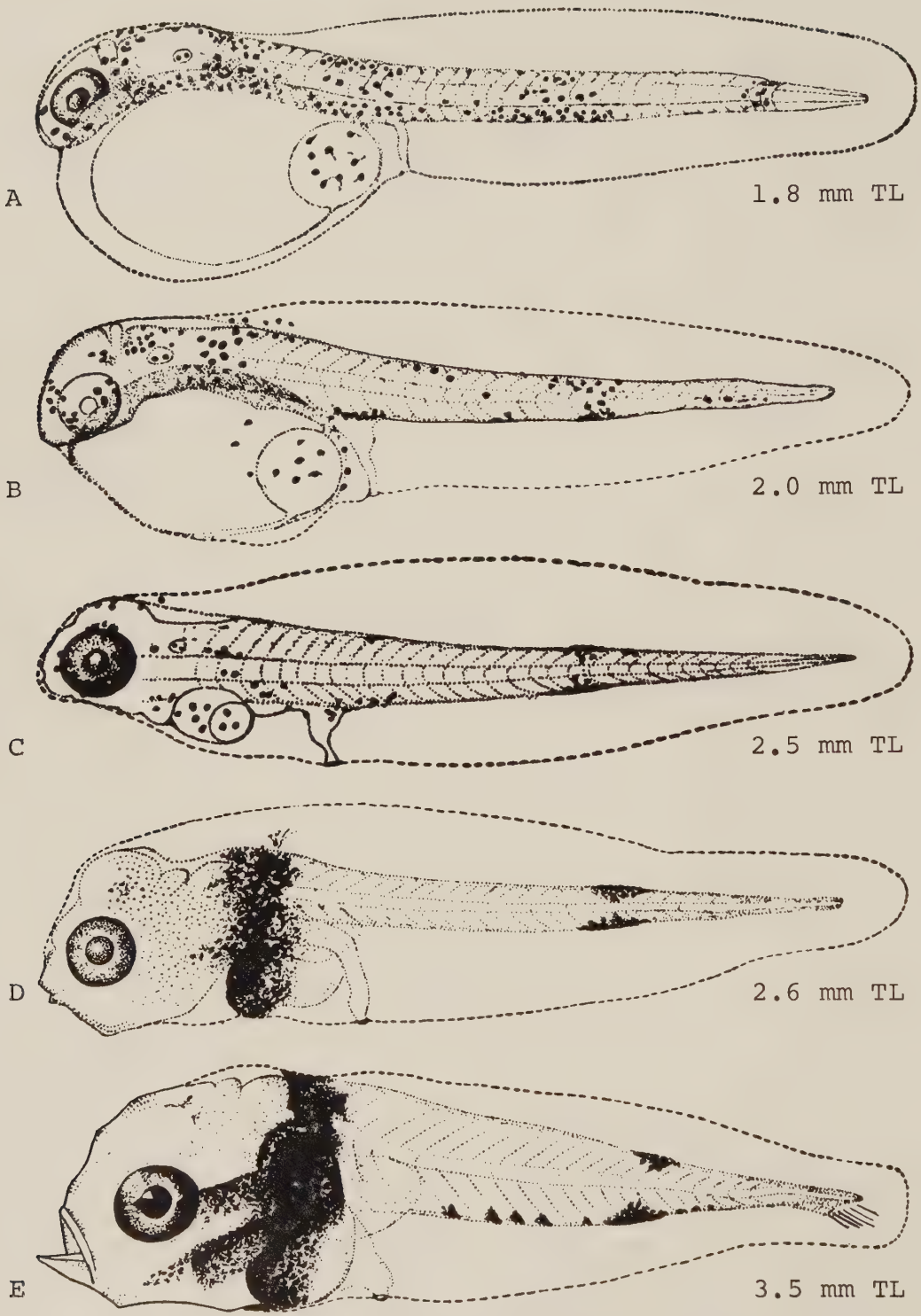

Fig. 102. *Bairdiella chrysoura,* Silver perch. A. Yolk-sac larva, newly hatched, 1.8 mm TL. B. Yolk-sac larva, 2.0 mm TL. C. Yolk-sac larva, 2.5 mm TL. D. Larva, 2.6 mm TL. E. Larva, 3.5 mm TL. (*A-E, Kuntz, A., 1915: figs. 16–20.*)

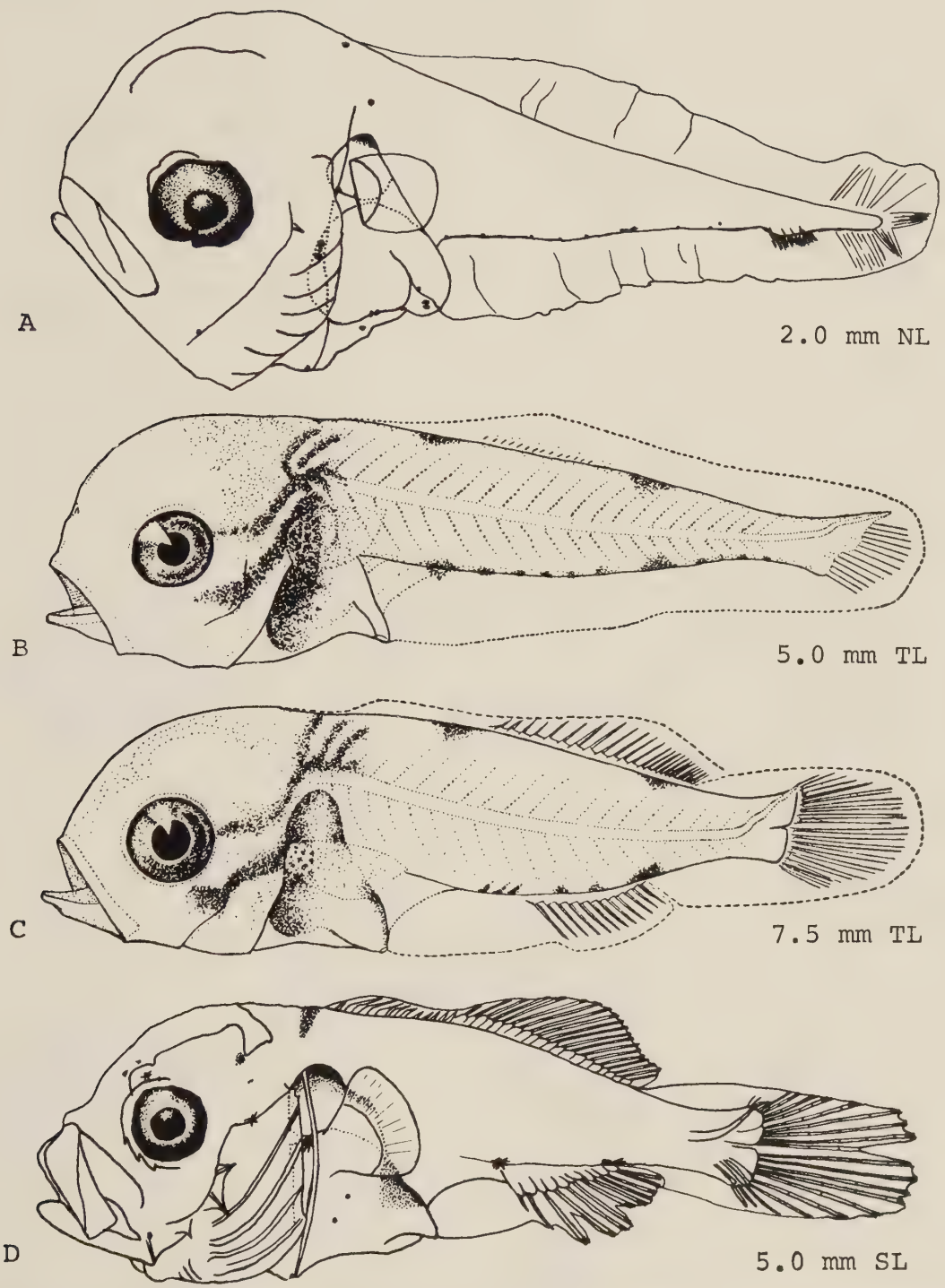

Fig. 103. *Bairdiella chrysoura,* Silver perch. A. Larva, 2.0 mm NL. B. Larva, 5.0 mm TL, identity questionable (HWP). C. Larva, 7.5 mm TL. D. Larva, 5.0 mm SL. (*A, D, Jannke, T. E., 1971: figs. 17A-B. B, C, Kuntz, A., 1915: figs. 21–22.*)

JUVENILES

Specimens described 10–30 mm.

All fins with full complement of rays by 10–12 mm.[1] At 22 mm posterior half of body covered with scales; at 33 mm body fully scaled.[12] At 30 mm form essentially that of adult.[1]

Pigmentation: At 11–12 mm only traces of pigment remain in previously pigmented areas.[1] At 15 mm melanophores well developed on head, along dorsal portion of body to about posterior end of spinous dorsal fin and on anterior portion of spinous dorsal membrane. By 22 mm dorsal portion of body pigmented and a row of melanophores along midline of body and along anal fin.[12] By 30 mm color essentially that of adult.[1]

GROWTH

In Delaware Bay, mean lengths at end of each month: June, 14.2 mm; July, 48 mm; August, 83.9 mm; September, 116.3 mm. In Delaware Bay, mean length each year

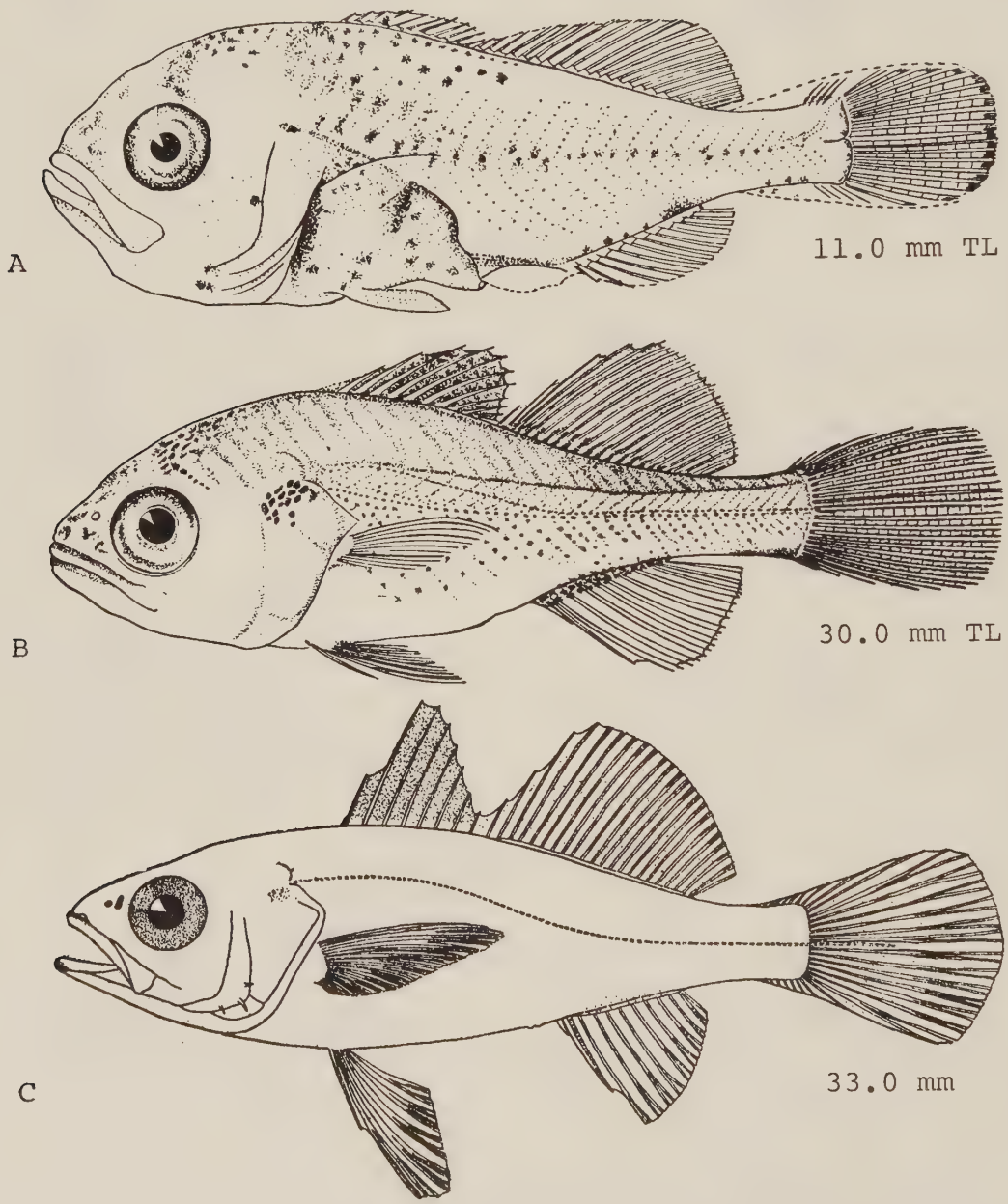

Fig. 104. *Bairdiella chrysoura*, Silver perch. A. Juvenile, 11.0 mm TL. B. Juvenile, 30.0 mm TL. C. Juvenile, 33.0 mm. (*A, B, Kuntz, A., 1915: figs. 23–24. C, Welsh, W. W., and C. M. Breder, Jr., 1923: fig. 33.*)

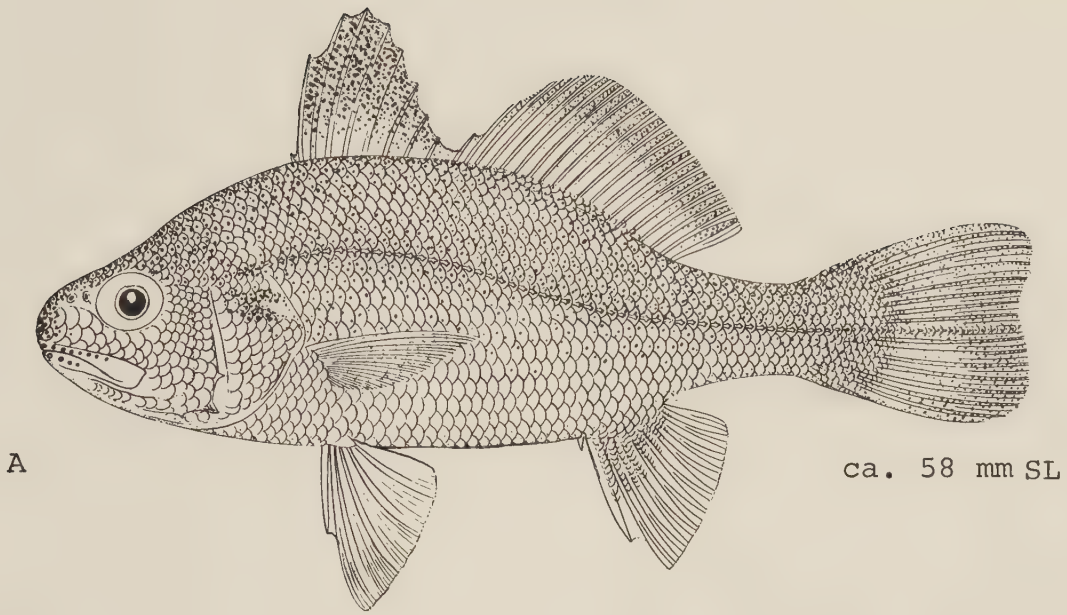

Fig. 105. *Bairdiella chrysoura,* Silver perch. A. Juvenile, ca. 58 mm SL. (*Fowler, H. W., 1945: fig. 276.*)

growth: I, 130.3 mm; II, 176.7 mm; III, 203.5 mm.[12] Beaufort, average lengths as follows: June, 8.7 mm; ly, 31.9 mm; September, 81 mm; February, 117.5 n.[24] Lengths of specimens from Beaufort and Chesa-ake areas: First winter, 60–140 mm; second winter, 0–200 mm; third season at spawning, 150–210 mm; owth slows after first spawning, largest examined 230 n at 6 years.[5]

GE AND SIZE AT MATURITY

me may mature in second year [12,27] but most probably ture in third year.[5,12,24] Reports of size at maturity nge from 130–140 mm [13,24] to 150–210 mm.[5]

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Cynoscion nebulosus (Cuvier), Spotted seatrout

ADULTS

D. X[9] (rarely IX[30] or XI)–I, 24[9,23]–28;[30] A. II, 9[2]–12[4] (typically 10–11[9]); C. 9+8, procurrent rays 6–9+5–7;[23] V. I, 5;[27] lateral line scales 90–102, scales between anal fin origin and lateral line 11–12;[9] vertebrae 13+12;[23] gill rakers 6[2]–9[30] on lower limb; branchiostegals 7;[27] a pair of large canine-like teeth at tip of upper jaw; remaining teeth small conical, set in narrow bands with outer row slightly enlarged in upper jaw and inner row distinctly enlarged in jaw (LNC); no teeth on vomer, palatines, or tongue.[27]

Head 2.9[9]–3.5,[27] depth 3.4[9]–4.5[27] in SL; snout 3.7–4.2, eye 4.4–5.3, interorbital 4.5–5.9, maxillary 2.2–2.3, pelvic fin 1.8–2.2 in head.[9]

Body elongate and somewhat compressed; back a little elevated; head long; snout pointed; mouth large, oblique; lower jaw projecting; maxillary reaching to or nearly to posterior margin of eye. Scales moderate, thin, all ctenoid, fins scaleless,[9] except for 1–10 rows of small scales at dorsal and anal fin bases (LNC). Dorsal fin continuous or slightly separate, the spines weak, flexible; anal fin small, second spine very weak; caudal fin straight to somewhat emarginate. Preopercular margin smooth, sometimes cilliated, never with strong serrations (LNC).

Pigmentation: Color dark gray above, with sky blue reflections, shading to a silvery below; upper parts of sides with numerous round black spots extending onto dorsal and caudal fins; fins pale to yellowish green.[9]

Readily distinguished from related species by the round black spots on upper parts of body and on dorsal and caudal fins, the small scales, and the scaleless median fins.[9]

Maximum size: Largest recorded about 7.2 kg.[9]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Cape Cod to Mexico;[17] most abundant in Florida and the Gulf states;[6] rare north of Delaware Bay.[8]

Area distribution: Chesapeake Bay, widespread;[9] Ocean City, Maryland;[20] Atlantic, Cape May, and Ocean counties, New Jersey.[21]

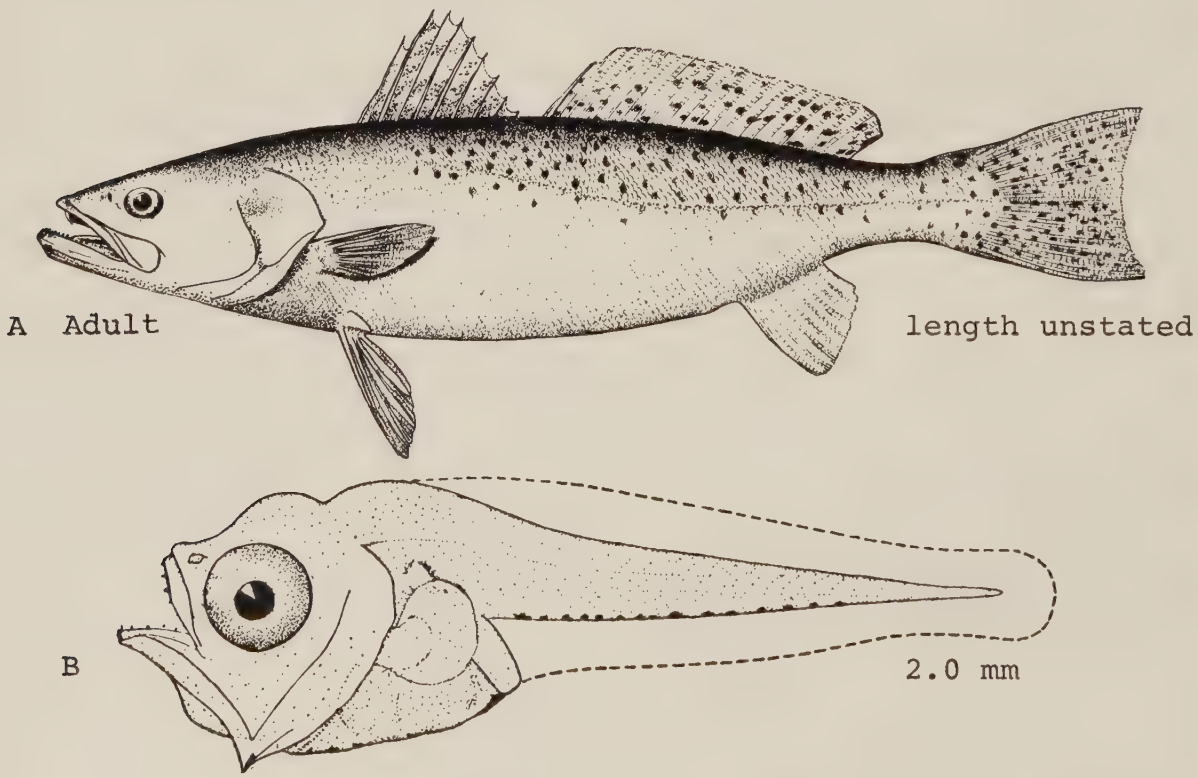

Fig. 106. *Cynoscion nebulosus*, Spotted seatrout. A. Adult, length unstated. B. Larva, 2.0 mm, putative. (*A, Goode, G. B., 1884: pl. 120. B, Hildebrand, S. F., and L. E. Cable, 1934: fig. 34.*)

ɔitat and movements: Adults—euryhaline, found in ly wide range of habitats, particularly in brackish s and lagoons;[5,6,8,11,15] most abundant in shallow as (1 to a few meters) over dense vegetation;[6] fre- ntly schooling until 5–6 years when most males have d and remaining females become semi-solitary.[17] In thern part of range resident year round, but less ndant in colder months when at least some move deeper bay water (channels, basins, deep holes) or n outside bays.[3,5,6,8] In northern and western part of ge, regular seasonal movements occur at onset of cold ather; in North Carolina, leave estuaries when tem- ature falls below 10 C and return in spring when peratures have risen to 10–12 C;[17] taken in Chesa- ke Bay March–December.[9] In tagging studies rarely ve over 32–48 km from release site;[25] in Florida, over of all returned tagged fish recovered within 48 km; longest movement about 500 km.[14] Found mostly at dium to low salinities (bays and estuaries)[8] but taken n 0[1]–77 ppt;[17] in Texas found mostly between 5–20 ;[20] also reported as most abundant in areas with nities between 15–35 ppt;[17] conspicuously absent m Baffin Bay, Texas when salinities reach 5 ppt;[8] no parent strong relationship between size and salinity.[18] ken in temperatures from 5[24]–34.9 C;[18] optimal tem- ature probably about 16–27 C; in Georgia leave shal- water when temperatures drop below 16 C or rise ve 25 C;[29] may not recover when exposed to about for about 12 hours, apparently always die when ex- ed to about 7 C for 24 hours;[11] adjust to temperature nge by moving to deeper channels and holes or off- re, however, in the Gulf states, mass mortalities have ulted from exceptionally severe cold waves[8,10,12,17] ticularly when accompanied by strong winds,[17] sibly as a result of poor access to deeper waters.[12]

vae—found in bottom vegetation (apparently prefer *ppia martima*) or shell rubble of channel bottoms and es of grass flats.[17] Recorded in the Everglades from nities of 23.5–37.4 ppt and temperatures of 16.4–31.8 but probably occur in considerably wider ranges DJ).

eniles—spend at least first 6–8 weeks in nursery unds;[10] mostly found within about 50 m of shoreline ally in vegetation[6,7] over semi-soft bottom[13] where y remain until winter when they move to deeper er;[6,7] specimens in the 20–40 mm SL range generally en June–November;[5,6,26] begin to school at about 75 mm.[13] Probably have about same salinity and perature tolerance as adults, but may sometimes be ed by freshets due to inability to move rapidly to an inlets.[17] To 0.5 ppt in Georgia.[31]

AWNING

ation: Occurs primarily within coastal bays and ons,[5,7,8,10] however in northern part of range (South Carolina to Virginia) may occur both in bays and in outside waters;[4] within the bays occurs either over shallow grassy areas[2,6] or in deeper holes and channels from which the eggs drift into the shallow vegetated areas;[5,12,13,17] little or no spawning occurring north of Delaware Bay.[2,5]

Season: Throughout Gulf of Mexico (north of Everglades) spawning extends from late March or early April to October;[3,5,6,10,14,15,18,22,26] ripe females reported as late as mid-November in Texas,[5] but may be egg bound females that never spawn;[8,16] some evidence for occurrence year round in Everglades, but much reduced during late fall and winter,[3,12] the peaks being around April–June[3] and September.[12] In mid-Atlantic states spawning occurs primarily in spring and summer,[2,29] peaking April[4]–May.[4,29] About 10 months of year apparently spent in ripening and spawning.[10]

Time: Apparently occurs at night.[17]

Salinity: In Florida peak occurs in dry spring months when salinity has risen to about 30–35‰; it is suspected that survival is low in upper lagoons and estuaries if salinity is significantly below 36 ppt,[17] however in the tidal passes such high salinities are probably not critical;[3] spawning not observed above 45 ppt.[19]

Temperature: Warm water necessary to allow spawning peak,[3] but peak not triggered by a single temperature,[12] and temperature is not the sole factor in determining peak, nor is it necessary for all spawning; spawning generally occurs in range of 24[3]–30 C.[12]

Fecundity: Estimates (eggs/individual female) based on specimens from (1) Florida,[13] (2) Louisiana,[16] (3) Texas:[10] (1) 325 mm SL, 15,000; 442 mm SL, 150,000; 500 mm SL, 400,000; 625 mm SL, 1,100,000.[13] (2) 283 mm TL, 140,485; 376 mm TL, 354,325; 450 mm TL, 660,960; 504 mm TL, 1,144,492.[16] (3) 254 mm, ca. 100,000; 305–354 mm, ca. 300,000; 457 mm, ca. 500,000; 5–8 years old, 600,000–1,500,000; average female produces 500,000–600,000 eggs. Only about one-third of eggs in ovaries remain viable for fertilization.[10]

EGGS

Initially buoyant, demersal after first 12 hours;[10] spherical;[17] unfertilized diameter 0.7–0.98 mm;[10] usually 1 oil droplet, occasionally 2–3.[17]

EGG DEVELOPMENT

Hatch in 40 hours at 25 C.[28]

YOLK-SAC LARVAE

Hatch at about 1.7 mm.

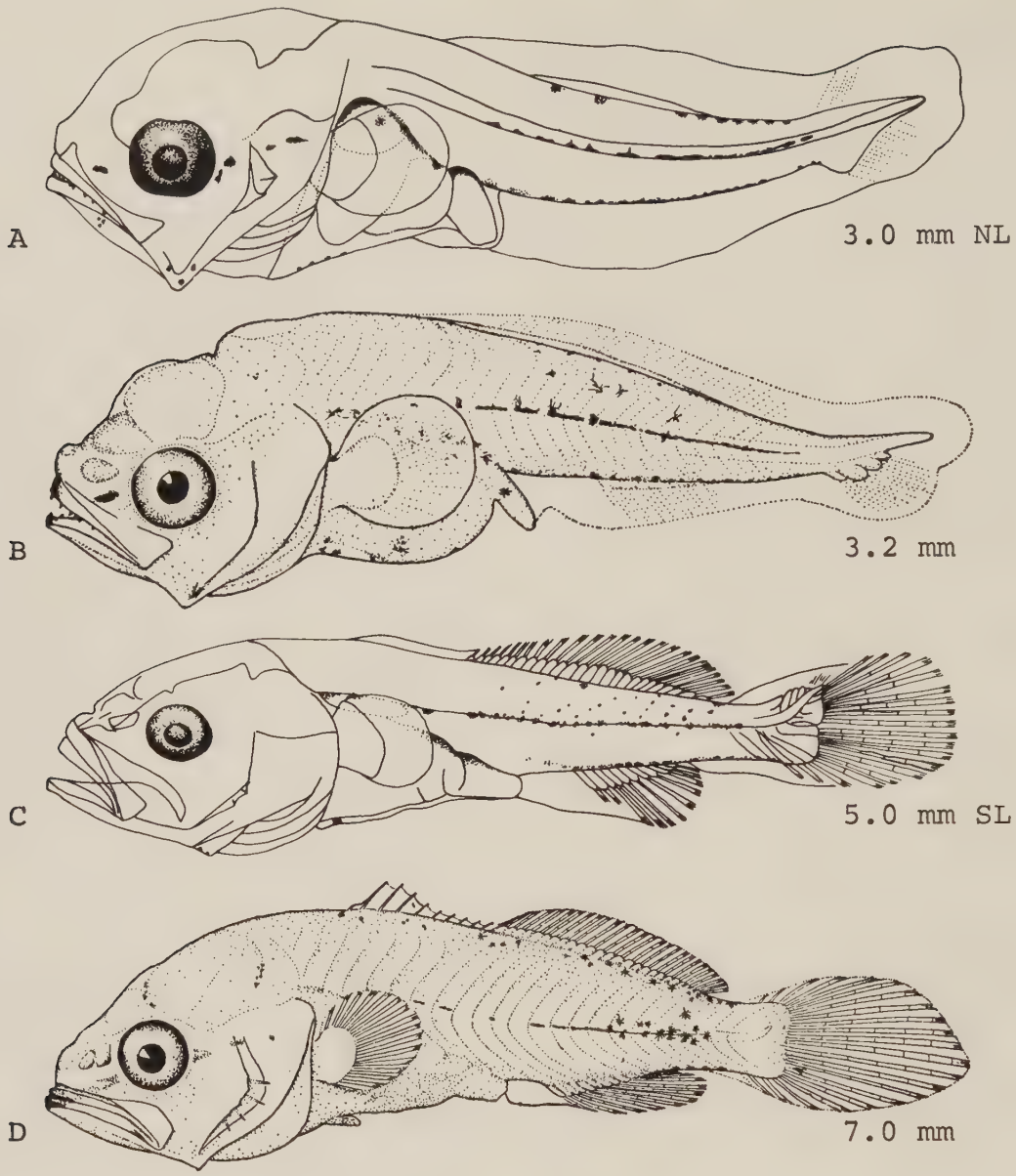

Fig. 107. *Cynoscion nebulosus,* Spotted seatrout. A. Larva, 3.0 mm NL. B. Larva, 3.2 mm. C. Larva, 5.0 mm SL. D. Larva, 7.0 mm. (*A, C, Jannke, T. E., 1971: figs. 19A, B. B, D, Hildebrand, S. F., and L. E. Cable, 1934: figs. 36–37.*)

Chromatophores arranged in groups with black chromatophores on dorsal surface of body and yellow chromatophores on sides behind eye and on underside of snout.[8]

LARVAE

About 1.8 mm to 10–12 mm.

At 1.8 mm no indication of median fin rays, some thickening at base of anal and caudal evident by 2.5 mm. At 3–3.6 mm definite thickening at base of dorsal and anal fins; by 7 mm anal and soft dorsal well developed, the soft dorsal with 26 rays, the anal with 11, the spinous dorsal rudimentary. At 3–3.6 mm a few caudal rays evident, notochord beginning to flex; at 7 mm caudal fin well developed, sharply pointed, but tip of notochord still visible. At 1.8 mm pectoral buds prominent; at 7 mm pectoral fin well developed, rays present. At 1.8–3.6 mm pelvic fin not evident; at 7 mm rudimentary, present as tufts of membrane shorter than half eye diameter (may appear as early as 4.8 mm SL, BWS). At 1.8 mm about 25 myomeres evident; at 2.5 mm, about 27 myomeres. At 1.8 mm body rather deep and compressed, becoming more elongate by 3–3.6 mm, quite elongate but compressed by 7 mm (3.3 in NL). At 1.8 mm anus in advance of mid-body; preanal distance 2.1–2.4, post-

l 1.7–1.9, body depth 3.1 in NL. At 2.5 mm anus ost exactly at mid-body; depth about 2.6 in NL. At .6 mm preanal distance 1.7–1.8, postanal distance -2.3, depth 3.4–3.6 in NL. At 7 mm preanal distance postanal distance to base of caudal 2.7, depth 3.3 SL.[4]

mentation: At 1.8 mm dark markings present on ven- outline of chest and abdomen, with a prominent spot iably present, BWS) immediately in advance of anus; eries of closely spaced black spots on anterior half to -thirds of ventral outline of tail; a few indefinite k, probably subsurface, marks present above abdomi- mass.[5] At 2.1 mm NL pigment present internally on atines, persisting to at least 32 mm (BWS). At 2.5 a black mid-lateral stripe of nearly connected darker anophores extends from above anus about halfway k tail; dots on ventral outline persist, somewhat less inct; dark dots also remain evident on ventral outline chest and abdomen. At 3–3.6 mm black mid-lateral pe more prominent, extending from shoulder nearly base of caudal fin; this stripe more continuous than in ller specimens and with some slight vertical projec- s making its edges somewhat ragged; a faint exten- extends across opercle and snout; lips dusky; surface black pigment present over abdominal mass; k markings along ventral outline of tail persist; a very small and indefinite dark points evident on tral surface of head and trunk.[4] At 4.8 mm SL a row black spots present on back, extending along base of sal fin (BWS). At 7 mm black lateral stripe persists, distinct; a definite black band present on snout in ance of eye and indefinitely on opercle behind eye; black; [4] a series of a various number of internal and ernal melanophores form an almost continuous row n above anterior anal base to posterior part of the dal peduncle through 12.7 mm SL (BWS); subsurface ment over abdominal mass persists, less distinct; ll dusky spots scattered over cranium; row of black ts on back persists.[4]

fer from *C. regalis* as follows: At 1.8 mm head and ak deeper, tail more slender; dark spots on ventral ine more prominent and more closely spaced. At 3.6 mm black mid-lateral stripe present and series of ts on ventral outline of uniform size, the one at mid- dal length not enlarged. At 7 mm body more slender snout more pointed; mid-lateral stripe and black kings present on head and back; no enlarged spot middle of anal fin base.[4]

VENILES

ut 10–12 mm to at least 180–200 mm.

0–12 mm spinous dorsal well developed but remains e low, the longest spine shorter than eye; at 16–20 spines longer, long as snout (about as in adult). At 10–12 mm caudal fin moderately long and pointed; at 16–20 mm longest ray as long as head without snout. At 10–12 mm pelvic fin complete but short, about equal to eye; at 16–20 mm about twice length of eye.[4] Scales form at about 10–12 mm; [12] at 16 mm scales evident on middle of side from shoulder nearly to base of caudal; at 20 mm body almost fully scaled; at 25–30 mm sheath of scales evident at bases of dorsal and anal fins. At 25–30 mm gill rakers well developed, 8 on lower limb. At 10–12 mm small spines present on margin of pre- opercle and interopercle. At 10–12 mm head 2.7–2.8, depth 3.8–4.2 in SL; at 16–30 mm body shape, and size and position of mouth close to adult; head 2.7–3.0, depth 3.9–4.2 in SL.[4]

Pigmentation: At 10–12 mm pigmentation little changed; a few additional dusky markings along black lateral stripe; dusky markings on head and back more numerous and intense. At 16 mm black lateral line disappears or becomes overlaid gradually by an indefinitely outlined dark band composed of numerous minute brownish or dark markings extending forward on side of head and snout and backward on basal half of caudal fin; dark dots on head and back much more numerous, those on back forming more or less definite longitudinal bands. At about 19 mm dark dots sometimes develop on spinous dorsal. At 25–30 mm a definite dark brownish band, with broken edges, extends from snout along side onto caudal fin; thin band broken from eye to opercular margin where it forms more or less disconnected blotches; at base of caudal this band crossed by a pale line, then continuing onto base of caudal fin where it is darker but less well defined, and ends in somewhat of a point; upper surface of head mostly brownish, this color extending onto back as 2 indefinite bands, one on each side of dorsal fin; posterior to spinous dorsal, these bands more or less broken up into blotches (more nearly continuous in some); a few dark dots present on dorsal fin, being most numerous on anterior margin of spinous dorsal; indications of scattered dark points present on anal fin; pectoral and pelvic fins unpigmented.[4] At about 40 mm ground color light, tinged with yellowish above and a silvery sheen below lateral line; brownish lateral stripe slightly narrower than eye, becoming discontinuous; pig- ment on opercle and caudal fin almost black; broken stripes on each side of dorsal fin persist, extending from tip of snout to base of caudal; tip of lower jaw brownish; spinous dorsal dusky, soft dorsal translucent with a nar- row median brown stripe; blackish area on caudal fin triangular; anal and paired fins translucent.[2] At 60–70 mm lateral band becomes divided into spots, and caudal fin is spotted; spots also develop between dorsal and lateral bands. At 70–80 mm entire upper half of side bears indefinitely outlined spots, irregular in shape and variable in size. At 110–120 mm the characteristic, roundish black spots of the adult, occupying the upper two-thirds of the sides as well as the dorsal and caudal fins, fully developed.[4]

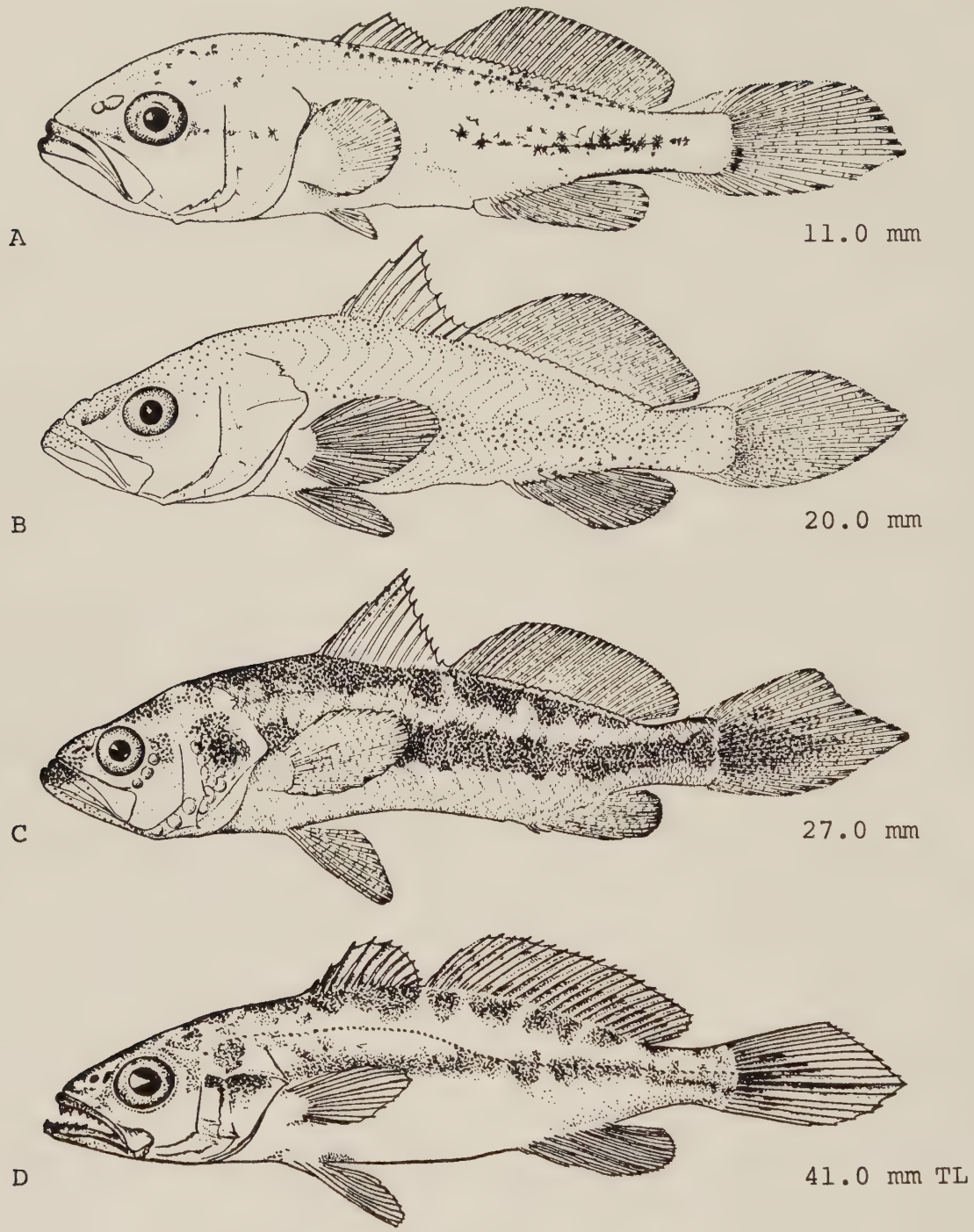

Fig. 108. *Cynoscion nebulosus,* Spotted seatrout. A. Larva, 11.0 mm. B. Juvenile, 20.0 mm. C. Juvenile, 27.0 mm. D. Juvenile, 41.0 mm TL. (*A-C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 38–40. D, Welsh, W. W., and C. M. Breder, Jr., 1923: fig. 16.*)

Fig. 109. *Cynoscion nebulosus,* Spotted seatrout. A. Juvenile, 58.0 mm TL. B. Juvenile, 110.0 mm TL. C. Juvenile, 120.0 mm TL. (*A-C, Welsh, W. W., and C. M. Breder, Jr., 1923: figs. 17–19.*)

Differ from *C. regalis* as follows: By about 26 mm full complement of lower limb gill rakers 7–8 in *C. nebulosus,* 11–12 in *C. regalis.*[4]

GROWTH

See Table 1.

A pronounced sexual dimorphism in growth rate; females grow more rapidly, reach peak abundance in population at a later age, and live longer than males.[5,12,13,14]

AGE AND SIZE AT MATURITY

Males may mature by end of first year, females by end of second,[15] but most males mature during second or third year and females during third or fourth.[13] Largest spawning classes, 2, 3, and 4 year olds (250–450 mm).[8] Sex determinable by about 90–100 mm.[10] In northwest Florida, smallest mature male found was 180 mm SL, smallest mature female 210 mm SL; all males mature by 250 mm, females by 270 mm.[16] Smallest mature female at Cedar Key, Florida 210 mm SL, males a little smaller; most mature by 240–250 mm SL.[6] In Everglades, size at first maturity 190–300 mm with no apparent difference between males and females.[12] On central east coast of Florida most males and females mature by 380 mm SL, but few females mature at 350 mm SL.[13] Population on northwest coast of Florida apparently matures at much smaller size than those on east coast, and has slower growth rate, probably as a result of several environmental factors:[15] relatively large amounts of large, shallow, brackish bays; absence of predators and com-

TABLE 1.—Mean calculated lengths in millimeters SL of *Cynoscion nebulosus* from different areas, based on scale analyses

Year	Northwest Florida [15]	Everglades, Florida [12]	Cocoa, Florida [11]	Punta Gorda, Florida [2]	Corpus Christi, Texas [5]
1	116	133	165	120	147
2	190	224	248	230	239
3	255	275	317	310	304
4	312	339	384	360	352
5	369	397	457	400	397
6	422	434	533	430	440
7	437	451	561	—	487
8	—	—	616	550	518

petitors; stability of temperature; abundance of fish, crustaceans and vegetation; and relatively large amount of 3–6 m deep areas adjacent to grass flats for winter refuge.[11]

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Cynoscion nothus (Holbrook), Silver seatrout

ADULTS

D. X–I,[10,13] 27–31 (usually 28–29 [1]); A. II,[10,13] 8–10 (predominantly 9, sometimes 8, in Atlantic infrequently 10 [1]); P. 9+8, procurrent rays 7–8+6–8; [13] V. I, 5; [4] scales 68–69 in a lateral series, about 8 between lateral line and anal origin; [10] vertebrae 14+13 [13] (27, very rarely 26 [1]); gill rakers 3–4+8–10 [18] (total frequently 12 or 14, rarely 15 [1]); branchiostegals 7; [7] a pair of large canine-like teeth at tip of upper jaw, the remainder small and conical, set in narrow bands with outer row slightly enlarged; lower jaw teeth large, widely spaced and in a single row, except at tip (LNC); no teeth on vomer, palatines or tongue.[10]

Head 3.2[10]–3.5,[17] depth 3.3 [10]–4.0 [2] in SL; snout 3.9 [10]–4.5,[17] eye 3.9–4.2, interorbital 4.5, maxillary 2.2 in head.[10]

Body elongated and rather compressed, back more strongly elevated than in related species; head long; [10] snout usually shorter than least depth of caudal peduncle; [1] mouth large, lower jaw projecting; [10] maxillary reaching to posterior margin of pupil. Scales rather large, thin, ctenoid on body, cycloid on most of head; membrane of soft dorsal fin covered with small scales beyond basal half. Caudal fin round, anal fin relatively small. Preopercular margin smooth (LNC).

Pigmentation: Color pale, without conspicuous pigment; straw or walnut above, lighter silver below; sometimes

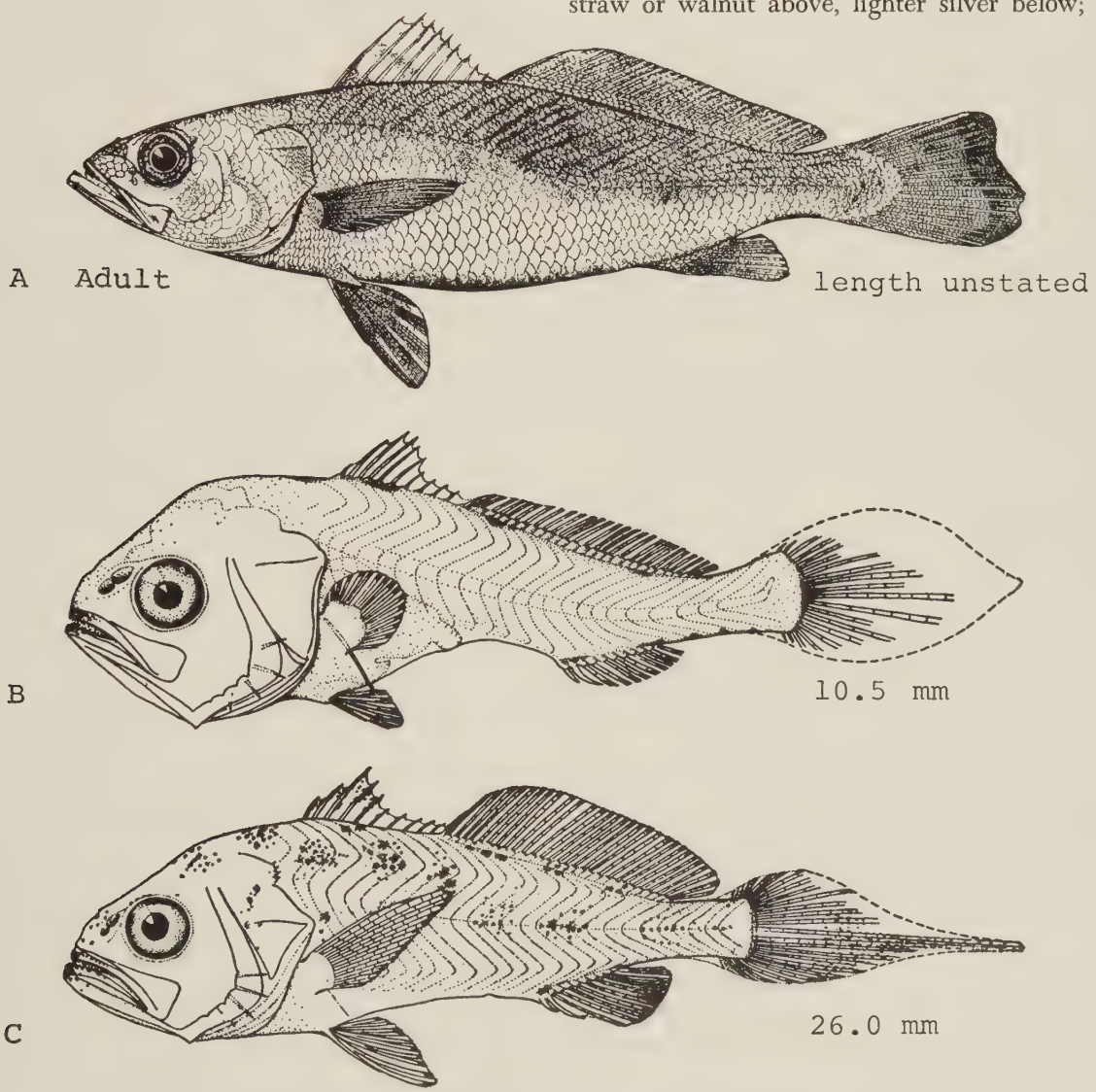

Fig. 110. *Cynoscion nothus*, Silver seatrout. A. Adult, length unstated. B. Juvenile, 10.5 mm. C. Juvenile, 26.0 mm. (*A, Ginsburg, I., 1929: fig. 5. B, C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 42–43.*)

indications of irregular rows of faint spots; [1] fins plain; pectoral axil dusky.[10]

Readily distinguished from related species by lack of conspicuous dark spots on back and upper sides, a somewhat rounded caudal fin (LNC), number of vertebrae (27), number of anal rays (usually 8 or 9), and relation of numbers of soft dorsal and anal rays (short anal in conjunction with a long dorsal).[1]

Maximum size: One of largest recorded 380 mm TL.[7]

DISTRIBUTION AND ECOLOGY

Range: Chesapeake Bay to southwestern coast of Texas.[1]

Area distribution: Chesapeake Bay (uncommon, LNC), Maryland and Virginia.[10,16]

Habitat and movements: Adults—most abundant in moderately deep outside waters, not a common inhabitant of bays; [3] in Georgia, taken within estuary, but most abundant outside; [4] in one survey off Texas abundance increased with distance offshore up to about 10–13 km.[15] Common in depths of about 10–20 m [14] to at least 65 m.[8] Common off Beaufort inlet in summer; [2] most abundant off Texas in March and April; [5] taken off Georgia in large quantities April–June.[4] In Texas apparently enters bays only during cooler months,[5,14] taken there December, January and May; [15] some indication that presence in Mississippi Sound occurs only during warmer months.[14] Prefer water of higher salinity; [5] taken from 7.5 [6]–38.6 [7] ppt, but mostly above 25 ppt [6] and largest specimens above 30 ppt.[5] Taken at temperatures from 10 [12]–29.9 C.[5]

Larvae—if similar to *C. nebulosus*, then may occur at surface when very small, but soon descend to bottom.[2]

Juveniles—found on bottom in same general vicinity as adults. Taken August–November at Beaufort; [2] largest catches of small fish taken during April, May and June, off Georgia, present April to November with 2 peaks of abundance; [4] off east coast of Florida, smallest specimens taken in October; [11] off Mississippi smallest specimens (under 28 mm) taken June–August and October; [12] off Alabama smallest taken in September; [6] off Texas smallest taken in June,[5] September,[9] October and November, common only in latter 2 months; [5] taken in much shallower water in October than September, possibly indicating shoreward approach and entrance into bays in winter.[9] Taken in temperatures from 5–29.9 C.[6]

SPAWNING

Location: Probably occurs offshore in same general vicinity inhabited by adults.[2,3,4]

Season: At Beaufort, probably begins in May or June and extends at least through August, with some indication of spring and fall peaks; [2] off Georgia, probably 2 peaks, the first beyond 18 km offshore in spring, the second closer inshore in late summer and fall; [4] some indication of spring and fall peaks off Texas.[14]

Temperature and salinity: Ripe male taken off Texas at about 10 m, 27 C, 36.7 ppt.[5]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Following description (from Hildebrand and Cable [2]) based on specimens of questionable identity (LNC).

About 9–11 mm to about 135–140 mm or larger.

At 9.5–11 mm all fins with full complement of rays. At 24–26 mm caudal fin sharply pointed, middle rays much longer than head; at 40–46 mm caudal fin remains long and pointed, the middle rays produced, nearly an eye diameter longer than head; at 150 mm caudal fin still moderately pointed, longest rays notably shorter than head; by about 200 mm caudal fin with adult shape, upper lobe slightly concave, lower lobe rather sharply rounded. At 9.5–11 mm pelvic fin small, scarcely as long as eye; at 24–26 mm about twice as long as eye. At 24–26 mm side partially covered with scales; at 40–46 mm body fully covered with scales and small scales evident on base of soft dorsal and anal fins; at 75 mm (and earlier in some) small scales present on basal portion of fins, exclusive of spinous dorsal; by 125 mm scales almost completely covering fins. At 24–26 mm gill rakers complete. At about 45 mm 2 large recurved canines in upper jaw evident, prominent by 75 mm. At 9.5–11 mm body depth 3.0–3.25 in SL, head 2.85–3.0 in SL, snout and eye about 3.7–4.4 in head, maxillary 1.6–1.8 in head; at 24–26 mm depth 3.2–3.6 in SL, head 2.5–2.75 in SL, snout and eye about 3.7–4.3 in head, maxillary 2.0–2.2 in head; at 75–90 mm depth 3.4–4.0 in SL, head 2.9–3.0 in SL; at 150–200 mm head 3.2–3.4 in SL.[2]

Pigmentation: At 9.5–11 mm preserved specimens pale, a few dusky markings evident along ventral outline of

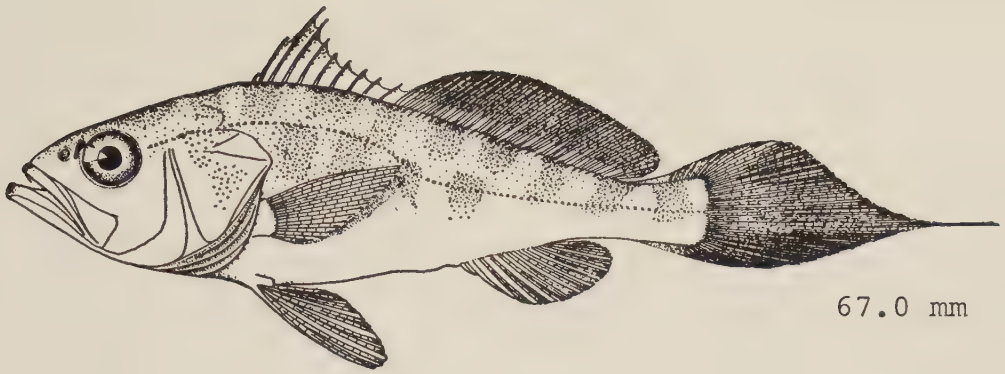

Fig. 111. *Cynoscion nothus,* Silver seatrout. A. Juvenile, 67.0 mm. (*Hildebrand, S. F., and L. E. Cable, 1934: fig. 44.*)

audal peduncle; an elongate dusky spot present at ase of anterior rays of anal fin and similar spots at osterior end of fin; a dusky spot situated just in advance f spinous dorsal, another under base of spinous dorsal, third under anterior rays of soft dorsal, and a fourth ear end of soft dorsal base (these markings not found n a 9.7 mm SL specimen examined by BWS). At 24–26 nm dark markings much more numerous, but remaining mall and scattered, present on sides, head, back, and long ventral outline; in some, congregations of dark narks present along lateral line forming indefinite quad-ate spots; in some a concentration of dark markings on ack forming saddle-like blotches; a dark cross line resent on base of caudal fin and a few dark dots on pinous dorsal. At 40–46 mm body more definitely lotched, the blotches consisting chiefly of a series along ateral line and another on back; blotches separate in ost, but in some those on anterior part of back tend to nite with those on side to form cross bars; dark dots resent on dorsal, caudal, and occasionally on anal fin. t 60 mm blotches indistinct; dark cross line on base of audal absent. At 75 mm only traces of blotches remain, nd these soon disappear, leaving the fish plain grayish bove and silvery below. At about 100 mm caudal fin uite dusky, almost black distally; dorsal fin densely otted, soon becoming dusky; spinous dorsal with a lack margin.[2]

n addition to differences given in adult diagnosis, differs rom *C. regalis* as follows: At 9.5–11 mm 2 elongate usky spots at base of anal fin, one at base of anterior nd one at base of posterior rays (*C. regalis* has only ne spot placed at base of middle rays). At 24–26 mm lotches less definite than in *C. regalis* and not connected o form crossbands on anterior part of body. At 40–46 m body blotched or, if crossbars present, less distinct an in *C. regalis* and only on anterior part of body; audal fins longer and more sharply pointed. At 75 mm caudal fin longer and more sharply pointed, fins more densely scaled.[2]

GROWTH

Off Beaufort apparently slower than other *Cynoscion* species, only about 75 mm by first 7–8 months;[2] off Georgia apparently more rapid than other *Cynoscion* species;[4] off Texas rapid, about 93–138 mm in first year.[5]

AGE AND SIZE AT MATURITY

Smallest mature females 135–140 mm off Texas.[15]

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Cynoscion regalis (Bloch and Schneider), Weakfish

ADULTS

D. X–I,[1,4,19,20] 24[20]–29 (modally 27[1]); A. II,[1,5,19,20] 10[20]–13[1,19] (modally 12[20]); C. 9+8,[16,20] procurrent rays 7–9+5–9;[20] V. I, 5;[19] scales 76–86 in a lateral series, about 10 rows between anal origin and lateral line;[5] vertebrae 13+12;[20] gill rakers 4–5+10–12[26] (typically 5+12[1]); branchiostegals 7;[19] a pair of large canine-like teeth at tip of upper jaw; remaining teeth small and conical, set in narrow bands with outer row slightly enlarged in upper jaw and a distinctly enlarged row from central to posterior position in lower jaw (LNC).

Head 2.9–3.3, depth 3.5–4.2 in SL. Snout 4.8–5.1, eye 3.1–5.6, interorbital 3.1–5.6, maxillary 2.1–2.4, pectoral fin 1.6–1.9 in head.[19]

Body elongate, moderately compressed; head long, snout pointed; mouth large, oblique, lower jaw projecting; maxillary reaching to posterior margin of pupil or beyond.[4] Dorsal fin with a deep notch between the spinous and soft portions (LNC), the spines flexible, third and fourth longest; anal fin relatively small, its base ending a little in advance of that of dorsal;[4] caudal fin emarginate in specimens less than 300 mm, the change from a

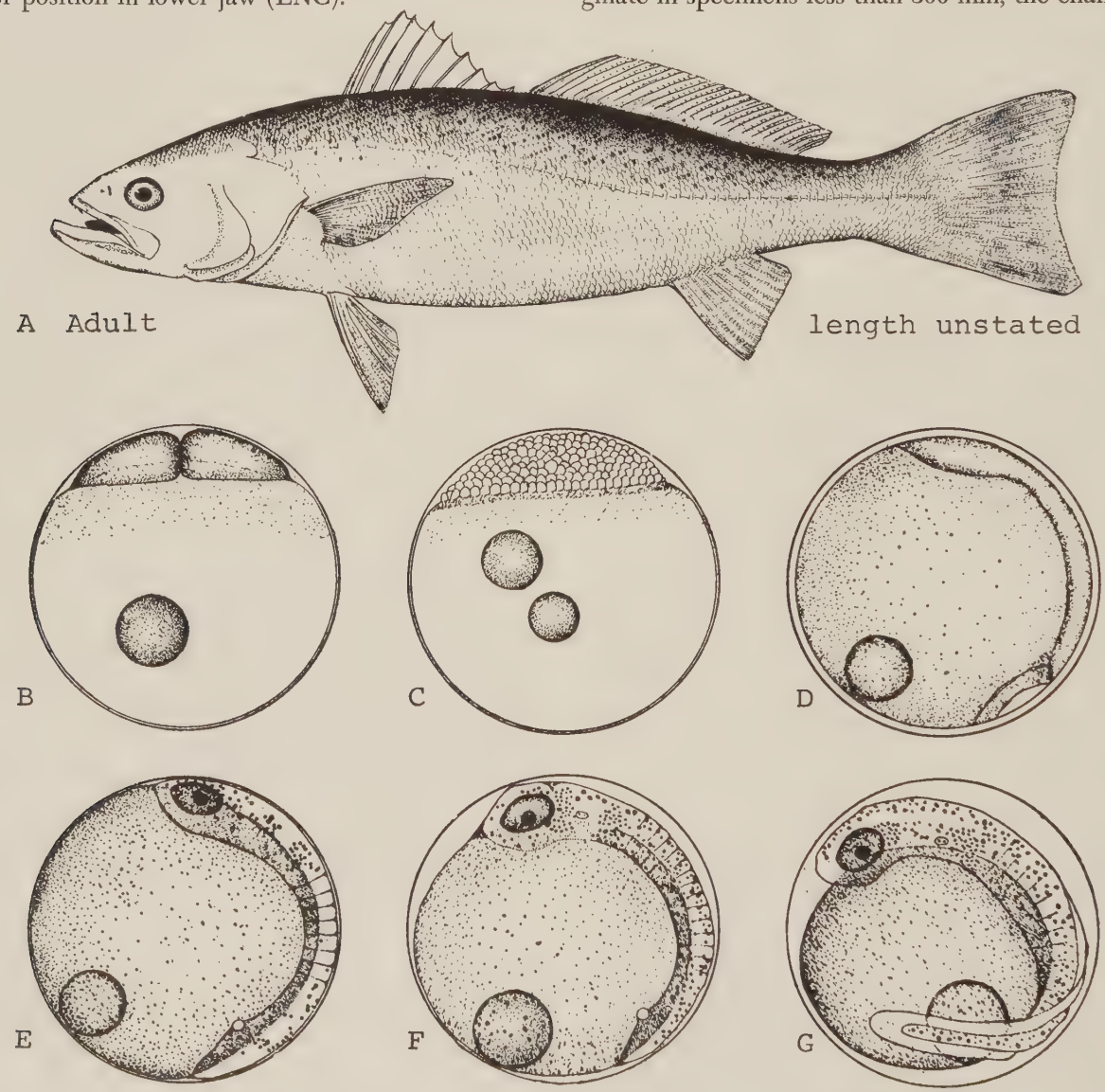

Fig. 112. *Cynoscion regalis*, Weakfish. A. Adult, length unstated. B. Egg with blastoderm of 2 cells. C. Egg with blastoderm in late cleavage stage. D. Egg, somewhat advanced stage. E. Egg with advanced embryo with 7 myomeres. F. Egg with advanced embryo with 13 myomeres. G. Egg with advanced embryo, shortly before hatching. (*A, Goode, G. B., 1884: pl. 120. B-G, Welsh, W. W., and C. M. Breder, Jr., 1923: figs. 2–7.*)

biconcave to an emarginate condition occurring at 250–300 mm; [1] pectoral fin not reaching to tip of pelvic fin.[4]

Pigmentation: Dark olive green above with the back and sides variously burnished with purple, lavender, green, blue, golden, or coppery,[12] and marked with a large number of small dark spots which appear as oblique streaks running along scale rows above lateral line (LNC); lower surface forward to tip of jaw white, chalky or silvery,[12] sometimes somewhat iridescent; [1] dorsal fins dusky, usually more or less tinged with yellow; caudal olive or dusky, the lower edge yellowish at base; pelvic and anal fins yellow; pectoral fin olive on outer side, usually yellow on inner side.[12]

Maximum size: Largest recorded about 7.9 kg; [9] fish larger than 900 mm and 5.4 kg rare,[32] the average size having declined considerably in this century.[31]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Nova Scotia [27,34] to east coast of Florida; [1,27] especially abundant from North Carolina northward,[4] centers of abundance include Chesapeake Bay, Delaware Bay, coastal areas of New Jersey, and the Peconic Bay system of Long Island.[31]

Area distribution: Chesapeake Bay, widespread in Maryland and Virginia; [4] Worcester County, Maryland; [24,25] ocean coast of Virginia; [28] Delaware Bay; [9,18] Cape May, Monmouth, Cumberland, and Ocean counties, New Jersey.[30]

Habitat and movements: Adults—found in surf, sounds, inlets, bays, channels, salt water creeks, and river estuaries; schooling fish with a marked preference for shallow, sand bottom areas.[31] First appear along middle Atlantic coast in April and May. In Delaware and Chesapeake areas spawn in cohorts, moving up bays until encountering low salinities, turning back and moving seaward, spawning near mouths of large estuaries; after spawning return to ocean, remaining near coast until July and August, when again seeking bays and sounds,[3] when the age class one year younger returns to spawn; [18] disappear in October and are not seen until following spring.[3] First appear in Delaware Bay in late April to early May, but by end of May in deeper waters of bay; by August few taken in bay; taken during October and November outside bay.[18] In Chesapeake Bay, large 2–3 year old fish enter bay in May, followed in June and July by smaller 1 year old fish; [12] some of 0–1 year fish from Chesapeake Bay found further north in succeeding years.[16] Some evidence that there may be 2 [15,33] or 3 [9] separate spawning populations along Atlantic coast; however, evidence not totally convincing.[17] Southern population has been suggested to move as follows: Juveniles leave coastal nursery areas and move to offshore waters off Virginia and North Carolina for winter; in spring yearlings move inshore to North Carolina coast, most moving north to Virginia by mid-August; return to wintering grounds by fall; following spring 2 year old fish move inshore and north along coast, some as far as New York; move back to wintering grounds in fall and continue this pattern for remainder of life.[12] Taken in salinities from 6.6 [36]–32.3 ppt and temperatures from 9.5 [28]–30.8 C.[6]

Larvae—sink to bottom by 8–10 mm [14] (possibly as early as 1.5–5.0 mm [7]) and may be carried upstream by subsurface currents.[8] Taken May–August in Chesapeake Bay,[14] July–August in Narragansett Bay.[21] Taken in salinities from 12.0–31.1 ppt and temperatures from 17.0–26.5 C.[8]

Juveniles—first summer prefer soft muddy bottoms [7] in low salinity areas [9] such as brackish coves and creeks.[14] In Delaware River estuary (an important nursery area) abundant in deeper water, August–December avoiding very shallow shore zone.[9] Distributed along Atlantic coast from Long Island to North Carolina in fall months; by winter most apparently move offshore and migrate to warmer water off Virginia and North Carolina.[33] First enter deeper waters in Delaware River in June, later dispersing to somewhat shallower areas; begin to move into bay in large numbers in August.[9] Most abundant in upper York River in July, migrating downstream September–November.[35] Taken March–October in Chesapeake Bay; many remain during greater part of first year of life, even November and December, but most seek warmer offshore waters.[14] Taken May–August in Georgia.[10] In Florida taken on bottom in 5–9 m throughout winter.[3] Euryhaline, entering fresh water [9] and taken in salinities as high as 31.7 ppt.[28]

SPAWNING

Location: Occurs within large estuaries [34] in deeper waters [10] or in inlets,[3,6,7] sheltered coves, and river mouths,[2] but some spawning may also occur outside estuaries, near their mouths.[7,8,14] Spawning questionably reported as far north as Gulf of Maine,[32] but magnitude in northern areas unknown; [6] progeny from spawning north of Chesapeake Bay considered by some insufficient to maintain northern stock [8] and it is thought that young from Carolinas and Chesapeake Bay are recruited to northern population as age III or older fish,[8,14,15,33] however this has not been adequately demonstrated.[6]

Season: Older fish enter Delaware Bay area, spawn and leave; as they leave, a second younger group enters during late June, spawn and leave, followed in August by a group of yearlings.[18] Spawning season extended in North Carolina; [3,6,7] males ripe March–August, females ripe April–August, spawn most of eggs in May or June [3,6] with a second spawning of lesser magnitude in late July or August; probably multiple spawnings by individual fish.[6] Occurs in late spring and summer in Delaware

Bay with 2 peaks, one in June, the other in July.[8,9] Occurs March–August in Georgia, with a peak March–May.[10] Some evidence of spawning as late as October on mid-Atlantic coast.[34] Eggs taken June–August in Narragansett Bay,[21] June–October in Block Island Sound,[23] and May–August in Long Island Sound.[5]

Temperature and salinity: Salinities from 12–32.5 ppt [8] and temperatures of 15.5–23.5 C.[21]

Fecundity: Size a better indicator of fecundity than age; a 500 mm SL female produces slightly over 2 million eggs; increase with age from 45,000 eggs for first year females to 1,726,000 for age IV females; [6] total seasonal production for Delaware River estuary might easily reach 450 billion eggs.[8]

EGGS

Initially buoyant, becoming heavier with development; [3,8] spherical; transparent, almost colorless; [3] widest reported range in diameter 0.68–1.18 mm,[23] range of mean diameters 0.84–0.96; [31] diameter decreases with increase in salinity [20] (in Delaware River estuary eggs taken from constant salinity varied in diameter about 0.1 mm, but eggs taken from different parents and incubated at different salinities varied 0.235 mm [8]); membrane thin and horny, slightly adhesive initially; 1–6 oil globules,[34] highly refractive; pale amber in color,[3] if single, mean diameter 0.22 mm,[34] if multiple, oil globules eventually coalesce [3] (after 90% of development time only about 16% contained 2 or more oil globules as compared to 38% after only 1 hour of development [8]); oil globule located far behind head of embryo; perivitelline space usually very narrow.[3]

EGG DEVELOPMENT

Within 2 hours after fertilization at 17.5 C a bulge of denser protoplasm appears at upper pole of egg; cleavage partly discoidal, the first cleavage plane appearing early parallel with egg axis.[8]

After 5 hours blastoderm present in advanced cleavage stage; blastoderm continues to expand and cells appear on one side to become free and form blastopore by an underturning; at this point blastoderm area becomes thickened into embryonic shield that envelopes yolk and delineates outline of future embryo; myomeres just discernible at this stage; yolk remains clear and unsegmented; oil globule remains posterior, below flexure of head and body.[8]

At about 12–14 hours after fertilization embryo extends halfway around yolk sac; shortly thereafter yellow chromatophores appear along sides of embryo and on surface of oil globule.[3]

At about 18–20 hours after fertilization number of chromatophores has greatly increased; in certain areas yellow chromatophores more or less grouped, especially behind eye, in a transverse band behind otocyst and on underside of snout; median ventral surface of body practically free from pigment; scattered black chromatophores present on dorsal surface of body and on oil globule; yellow chromatophores persist on surface of yolk sac, either aggregated or evenly scattered.[3]

By 37–39 hours, embryo surrounds about seven-eighths of yolk; pectoral fin buds evident; heartbeat easily seen.[8]

Hatch in about 1000 degree hours within temperature range of 12–31.5 C; optimum hatching occurs between 18–24 C; successful hatching will occur at salinities from 10–33 ppt; reduction of dissolved oxygen to 4.3 ppm reduces scope of successful hatching and 2.4 ppm prevents all hatching; changes in magnitude of 6 C and 5–6 ppt salinity may have decided detrimental effects on survival of developing eggs.[8]

YOLK-SAC LARVAE

Hatch at 1.49–1.99 mm TL [8] (average 1.8 mm [3,8]).

Yolk sac relatively large at hatching, oil globule at its posterior end; anus immediately behind yolk sac; body very elongate, slender, depth 4–4.5 in NL.[14]

At 2.2 mm yolk sac much reduced; oil globule more median in position; pectoral fin distinct.[3]

Pigmentation: At hatching pigmentation about same as in egg, but chromatophores somewhat less numerous. About 8 hours after hatching the yellow pigment spots are aggregated about eye and behind otocyst and form 2 more or less distinct bands on body behind anus. About 24 hours after hatching (about 2.2 mm) arrangement of pigment about same with an additional band of yellow chromatophores posteriorly.[3]

LARVAE

Specimens described 3.5 mm SL to 10.1 mm SL.

At 3.5 mm SL dorsal and anal fin rays slightly differentiated; by 5.9 mm SL anal fin fully developed; by 7.4 mm SL dorsal fin fully developed (BWS). Caudal fin rays evident at 4.6 mm. At 4.6–8.2 mm depth 2.7–3.0 in NL.[14] At 2.7 mm NL minute teeth evident (BWS).

Pigmentation: At 3 mm a series of chromatophores along ventral edge of body, the one at mid-caudal length particularly pronounced; [14] internal pigment present on gut, on dorsal midline below termination of dorsal fin, in or at nape, under hindbrain and over anterior abdominal vertebrae; dorsal and nape pigment persists in larger sizes (BWS).

At 4.6 mm series of ventral chromatophores mostly gone, except spot at base of anal which appears enlarged and

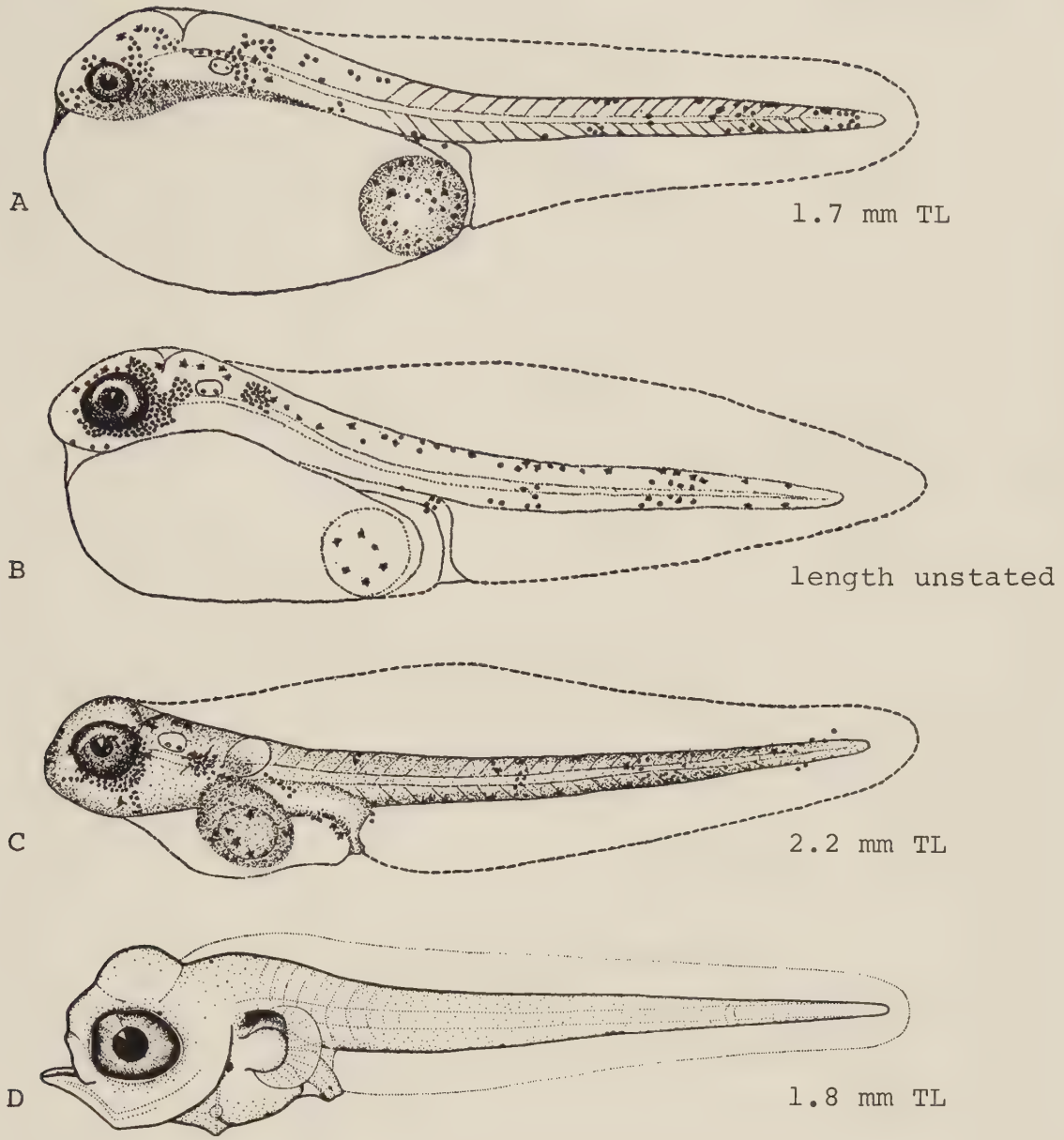

Fig. 113. *Cynoscion regalis,* Weakfish. A. Yolk-sac larva, 1.7 mm TL. B. Yolk-sac larva, length unstated. C. Yolk-sac larva, 2.2 mm TL. D. Larva, 1.8 mm TL. (*A-C, Welsh, W. W., and C. M. Breder, Jr., 1923: figs. 8–10. D, Pearson, J. C., 1941: fig. 16.*)

anastomosed (a character distinguishing *C. regalis* from *nebulosus* and *nothus*); markings on abdominal cavity pronounced [14] and an internal pigment spot present in musculature between anus and anal origin (BWS).

At 6.5 mm row of about 8 rather large chromatophores along lateral line forming 2 groups, one above anal fin and the other below anterior part of soft dorsal, each group having a few smaller chromatophores above and below it; large chromatophore at base of anal fin prominent; other large chromatophores present on underside of head, at base of spinous dorsal, and on ventral edge of caudal peduncle; pigment of posterior portion of body cavity also visible.[2]

At 8.2 mm chromatophore at base of anal fin extremely pronounced; abdominal markings somewhat reduced.[14]

By 10.1 mm SL mid-lateral pigment arranged in 4 groups: Above middle part of anal fin (first appears at 5.9 mm SL); below spinous dorsal (first appears at 5.9 mm SL); below anterior soft dorsal (first appears at 7.4 mm SL); on caudal peduncle (first appears at 10.1 mm SL) (BWS).

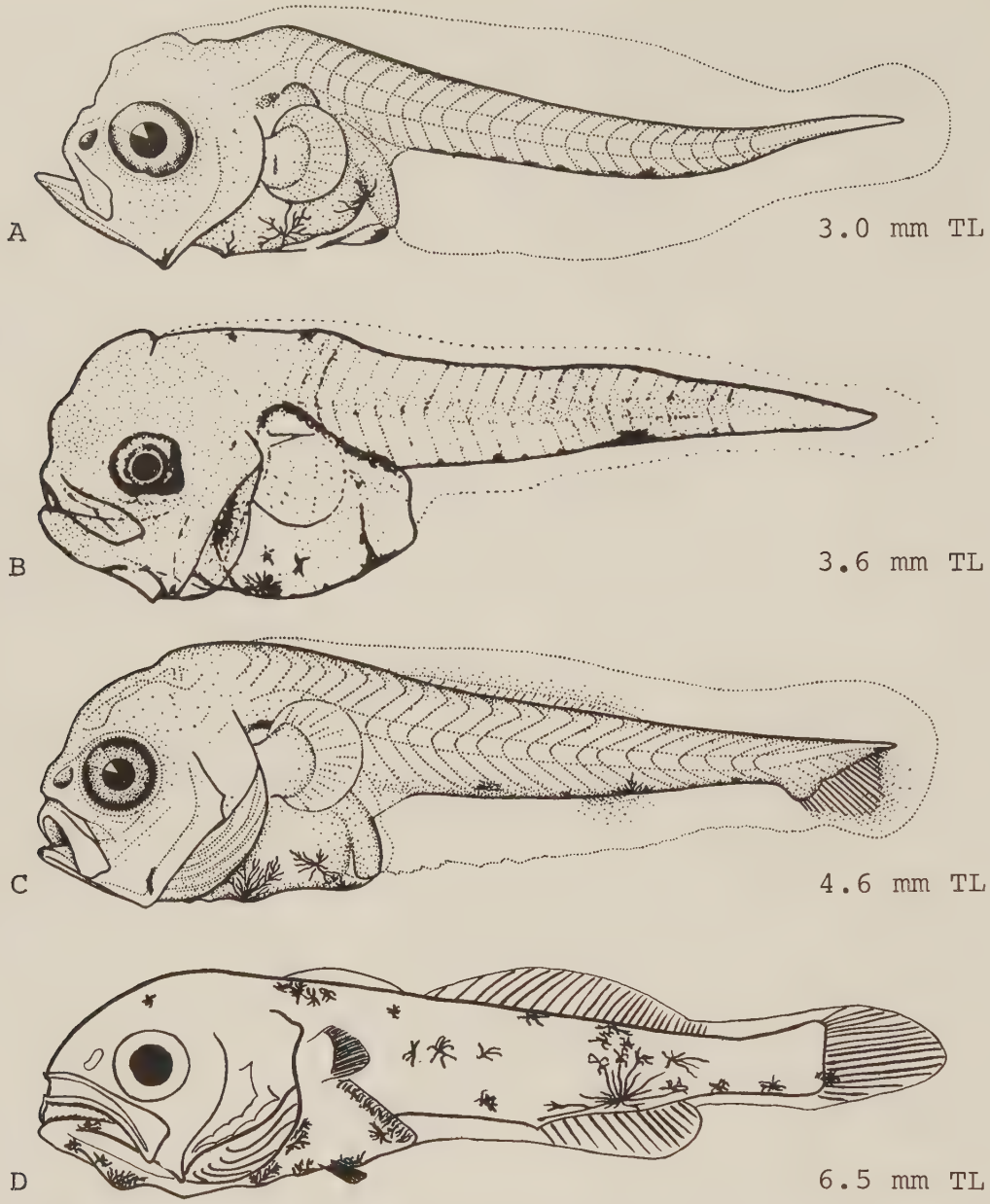

Fig. 114. *Cynoscion regalis*, Weakfish. A. Larva, 3.0 mm TL. B. Larva, 3.6 mm TL. C. Larva, 4.6 mm TL. D. Larva, 6.5 mm TL. (*A, Pearson, J. C., 1941: fig. 17. B, C, Perlmutter, A., 1939: fig. 8A. D, Tracy, H. C., 1908: pl. 10.*)

JUVENILES

Specimens described 10.5 mm to 180 mm.

At 12.5 mm dorsal and anal fins fully differentiated.[2] Caudal fin symmetrically pointed at 10.5 mm. At 17 mm depth 3.3–3.4 in SL, body becoming more slender and elongate.[14] Teeth well developed by 12.5 mm.[3]

Pigmentation: At 10.5 mm lateral chromatophores profuse; spot at anal base persists. At 17 mm heavy lateral chromatophores in 4 indistinct vertical bands or saddles; chromatophore at base of anal absent; amount and intensity of lateral pigment depends on type of environment.[14]

At 12.2 mm SL internal pigment expands to cover dorsal surface of all vertebrae anterior to one above middle part of anal fin (BWS).

At 12.5 mm (identity of specimen questionable, could be *C. nebulosus*, BWS) chromatophores on lateral line have increased in number, extending along nearly entire length; also a group of chromatophores just under spi-

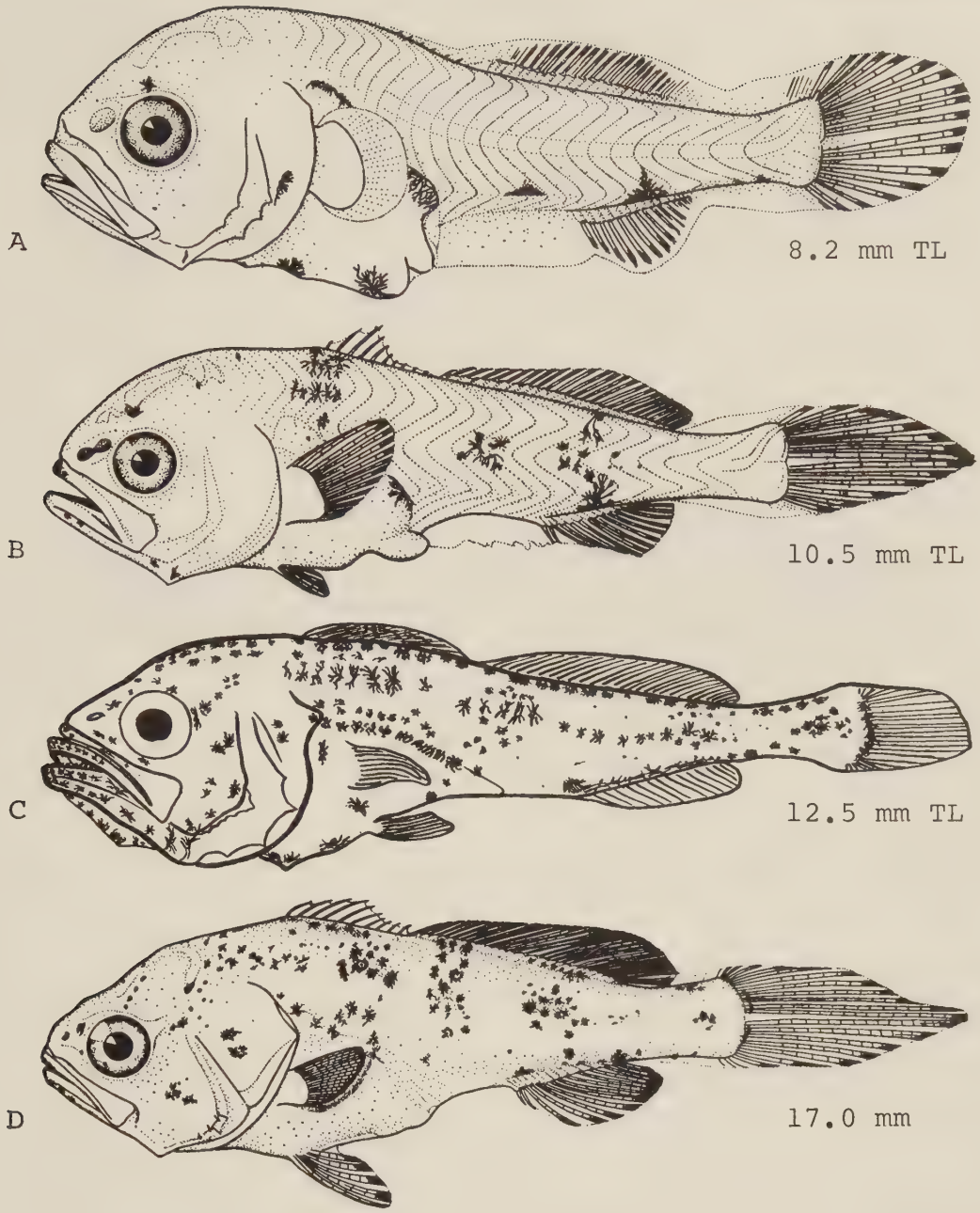

Fig. 115. *Cynoscion regalis,* Weakfish. A. Larva, 8.2 mm TL. B. Juvenile, 10.5 mm TL. C. Juvenile, 12.5 mm TL, putative, may be *C. nebulosus* (BWS). D. Juvenile, 17.0 mm. (*A, B, D, Pearson, J. C., 1941: figs. 19–21. C, Tracy, H. C., 1908: pl. 11.*)

nous dorsal and another in front of base of caudal fin; row of branched anastomosing chromatophores runs vertically along base of caudal fin rays and a similar row runs along base of anal fin; 2 or 3 rows of compact chromatophores run along back parallel to dorsal fin, and 3 or 4 short rows run longitudinally on top of head; 2 or 3 branched, somewhat tenuous pigment cells lie in membrane of spinous dorsal and scattered chromatophores occur along opercle, on upper and lower jaws and on various other parts of body.[2]

At 32 mm 4 distinct saddles still present, first under spinous dorsal, second and third under second dorsal, fourth on caudal peduncle; with increase in size additional bands added between these 4, the first between the 2 under the soft dorsal, another below end of soft dorsal, the last one between the 2 dorsal fins, all of these being formed by 44 mm.[16]

At 75 mm bars still faintly visible, but entire fish dusky on sides, back, and fins, with a distinct black border to

Fig. 116. *Cynoscion regalis*, Weakfish. A. Juvenile, 32.0 mm. B. Juvenile, ca. 45 mm. (*A, Pearson, J. C., 1941: fig. 22. B, Hildebrand, S. F., and W. C. Schroeder, 1928: fig. 181.*)

the dorsal and caudal fin.[16]

At 110 mm bars of younger stages entirely obliterated and superficial pigment shows characteristic oblique streaking of adult, but much less conspicuous than in adult.[16]

At 180 mm oblique marks along scale rows very distinct, broken and less uniform in larger specimens, giving a more blotched appearance.[3]

GROWTH

Average TL of New Jersey fish hatched June 1: 30 mm, July 1; 80 mm, August 1; 130 mm, September 1; 170 mm, October 1; 180 mm, November 1. Estimated average TL by scale analysis of Cape May, New Jersey specimens: 100–130 mm, first winter; 210 mm, second winter; 280 mm, third winter; 330 mm, fourth winter; 360 mm, fifth winter.[3] In Delaware Bay reach about 190–200 mm by end of first year, about 245 mm by end of second year.[9] At Beaufort, average 150.4 mm by October, 168.8 mm by December.[7] Northern populations grow more rapidly.[15]

AGE AND SIZE AT MATURITY

In North Carolina both sexes reach maturity as yearlings, but some smaller members do not mature until second year.[6] Reported that New Jersey males mature at 2–3 years, females at 3–4 years; majority on spawning grounds at Cape May 4–6 years old.[3] In Morehead City area at least 50% of males about 130 mm SL mature, and at least 50% of females about 150 mm SL mature; at Pamlico Sound at least 50% of males 145 mm SL mature, and at least 50% of females about 190 mm SL mature.[6] Maximum age more than 8 years (LNC).

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Larimus fasciatus Holbrook, Banded drum

ADULTS

D. X [2,4,13] (occasionally XI [13])–I, 24–28; [2,4] A. II, 6–8; [2,4] C. 9+8, procurrent rays 6–7+4–7; [13] V. I, 5; [14] vertebrae 10+15; [13] gill rakers 11–13+22–25; [15] branchiostegals 7; [4] teeth minute, set in a narrow ridge with 1 to 2 rows in jaws (LNC); no teeth on vomer, palatines, or tongue.[4]

Head 2.9–3.7, depth 2.4–2.8 in SL; snout 3.7–4.5, eye 3.0–3.8, interorbital 2.8–3.1, maxillary 1.8–2.5, pectoral fin 1.0–1.3 in head.[4]

Body rather deep, compressed; [4] back somewhat elevated; [14] head short, deep; snout very short, blunt; mouth very oblique; [3] lower jaw protruding, chin without barbels; maxillary reaching to about middle of eye; [4] mandible with a slight knob at symphysis, a pair of small pores on each side of it.[14] Scales moderate, ctenoid, extending forward on head, cheeks, and opercles; small scales present at least on base of fin. Dorsal fin continuous with a deep notch between the soft and spinous portions (LNC); dorsal spines slender, flexible, the third and fourth the longest; anal fin short, the second spine large and strong; caudal fin slightly rounded,[4] the middle rays the longest.[2] Skull firm but cavernous (LNC).

Pigmentation: Color in life grayish olive above, silvery below; back with 7–9 conspicuous dark vertical bars extending to below middle of sides; fins dusky olive; anal fin and lower rays of caudal fin yellow; pelvic fins orange yellow, dusky toward tip; lower side of head very bright silvery; inside and lining of gill cavity, cheeks, and opercles with some light yellow.[6,14] Color in alcohol grayish above, silvery below; sides with 7–9 vertical black bars; fins plain with dusky punctulations.[4]

Easily recognized by deep compressed body, strongly oblique mouth, and 7–9 black crossbars.[2]

Maximum size: Seldom exceeding 245 mm.[3]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts to Florida, and the northern Gulf of Mexico; [11] not abundant north of Cape Hatteras, although stragglers have been taken as far north as Woods Hole.[1]

Area distribution: Chesapeake Bay at Cape Charles City and Lynnhaven Roads, Virginia; [4] in bays along the outer coast of Maryland; [6] New Jersey.[10]

Habitat and movements: Adults—occurring near the bottom [2] over sand or sandy mud in depths of a few meters [2,3] to at least 60 m; [12] off Mississippi majority taken from 26–54 m; [7] taken year round at Beaufort, North Carolina, inshore to as much as 20 km offshore.[2] Taken in salinities from 18.0–38.7 ppt and temperatures from 14.5 [7]–32.5 C.[8]

Larvae—taken in neuston and midwater bongo net tows (HWP) and in bottom trawls; taken July–October at Beaufort in same general vicinity where adults occur year round.[2]

Juveniles—taken in same general vicinity as adults at Beaufort.[2] Taken in salinities from 26.7–35.2 ppt [5] and temperatures from 6 [10]–27.8 C.[9]

SPAWNING

Location: Probably occurs in same general vicinity that adults occupy year round.[2]

Season: Evidently begins as early as May and extends through October at Beaufort [2] and in Gulf of Mexico.[9]

EGGS

Undescribed, probably planktonic.[2]

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

2.3 mm or less to about 15–17 mm.

At 3.6 mm SL dorsal and anal fin folds with slight indication of rays (HWP); at 4.5 mm about 36 total dorsal rays and about 7 total anal rays,[2] spines and rays fairly evenly differentiated; at 5 mm SL dorsal and anal fins with full complement of spines and soft rays. At 5 mm SL caudal fin with full complement of principal rays. At 4.3 mm SL pectoral fin rays beginning to develop (HWP); at 7 mm pectoral fin reaches anal origin; at 9.0–10.5 mm pectoral fin reaches to or past middle of anal base. At 1.9–2 mm body depth 4.1 in NL, anus to tip of notochord 2.2 in NL; at 2.3–2.6 mm depth 2.8–3.2 in NL; at 3–3.5 mm depth 2.3 in NL; at 7 mm depth 2.3 in TL, anus to tip of caudal base 3.8 in TL; at 9–10.5 mm depth 1.9 in TL. At 1.9–2.6 mm mouth moderately large and oblique, maxillary reaches to pupil; at 3–4.5 mm maxillary reaches to about middle of orbit; at 7 mm maxillary reaches slightly beyond middle of orbit; at 9–10.5 mm mouth less strongly oblique. At 1.9–2 mm total myomeres about 25.[2]

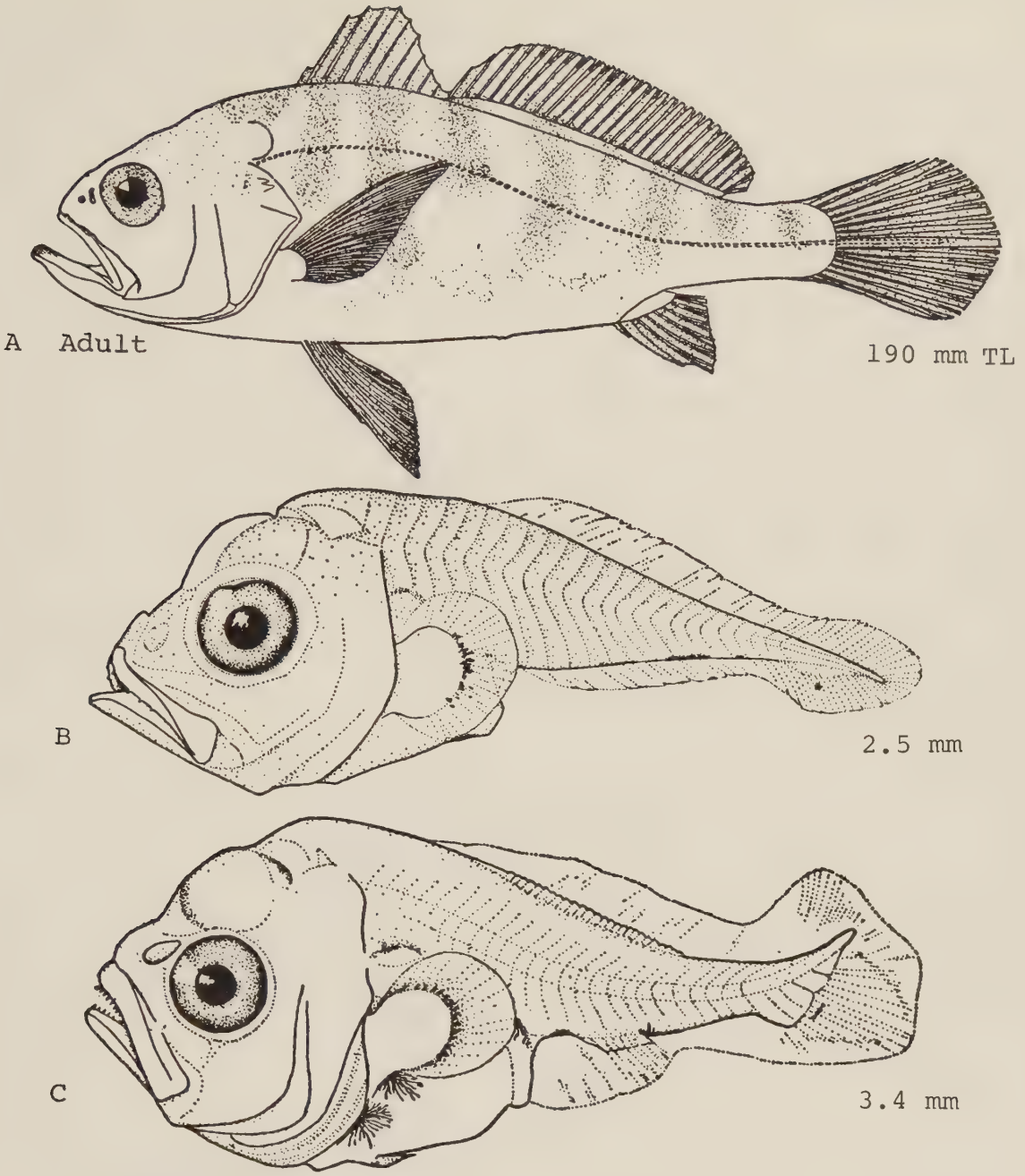

Fig. 117. *Larimus fasciatus,* Banded drum. A. Adult, 190 mm TL. B. Larva, 2.5 mm. C. Larva, 3.4 mm. (*A, Welsh, W. W., and C. M. Breder, Jr., 1923: fig. 22. B, C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 27–28.*) *Larval pigmentation not adequately shown in 2.5 mm and 3.4 mm specimens, see text.*

Pigmentation: **Note:** *The following color description is based in part on Hildebrand and Cable's description of specimens which they misidentified as* Stellifer (*as pointed out by HWP*).

At 1.9–2 mm a dark spot present at anus, a large and more distinct one at midcaudal length, and a third and smaller one about halfway between the latter one and tip of notochord; pectoral axil black; dark points on sides along upper margin of abdomen; 3 dark dots on dorsal outline, first slightly ahead of anterior margin, second a little behind posterior margin of eye, third a half eye diameter behind second. At 2.3–3.5 mm preserved specimens brownish; ventral outline of abdomen slightly dusky, with a small black spot just behind gill membranes and usually one behind anus; 2–3 black spots on

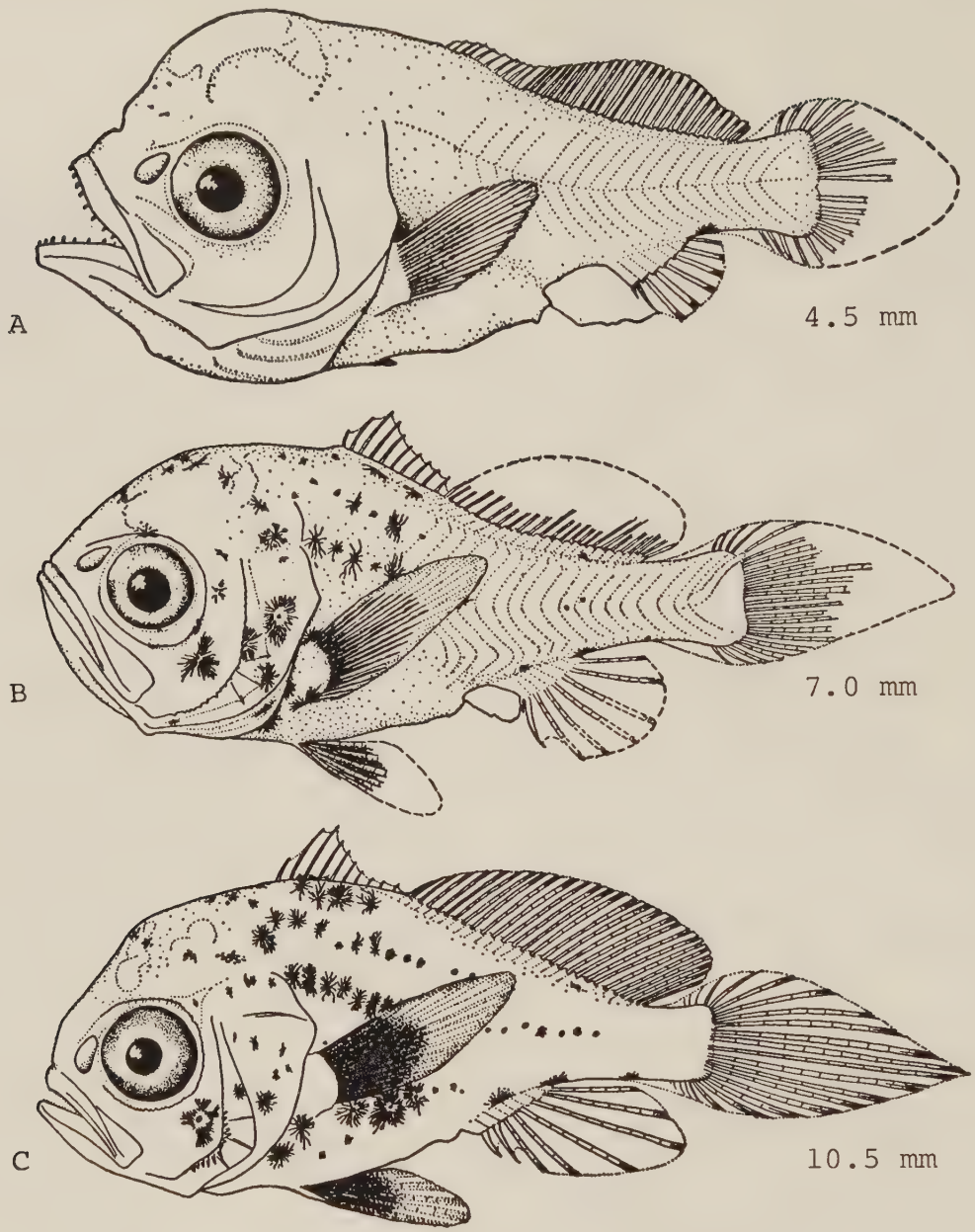

Fig. 118. *Larimus fasciatus,* Banded drum. A. Larva, 4.5 mm. Pigmentation not adequately shown, see text. B. Larva, 7.0 mm. C. Larva, 10.5 mm. (*A-C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 29–31.*)

ventral outline of tail, the first (if present) a short distance behind anus, the second near mid-caudal length, the third about midway between the second and tip of notochord; pectoral axil black; the 3 dark markings on head now have appearance of dark cross partitions, lying below surface of skull. At 3–3.5 mm pigmentation on chest and abdomen has increased; a short dark cross line, preceded by a median black spot usually present on chest; a few distinct dark points at base of pelvic fin and a rather distinct short dark bar across abdomen behind pelvic; elongate dark spot at about mid-length of ventral outline of tail now situated at or near end of anal fin base and occasionally a black point present directly over it on dorsal outline; in some a small dark spot also present at anal fin origin; black pectoral axil and dark shoulder spot persist. At 4.5 mm preserved specimens dark brown; anterior part of abdomen dusky [2] and the dark spot on ventral outline of tail still present immediately at posterior end of anal fin base (HWP); pectoral axil remains black. At 7 mm numerous black chromatophores present; characteristic black spot at posterior end of base of anal fin and the black pectoral axil persist; base of

pelvic fin dusky. At 9–10.5 mm black pigment spots more numerous; black spot behind anal fin more elongate and branched; basal half of both pectoral and pelvic fins black.[2]

Distinguishing features are the melanophores on anterior surface of forebrain and anterior and posterior surfaces of midbrain and the black pectoral axil (HWP).

JUVENILES

About 15–17 mm and larger.

At 15–17 mm dorsal and anal fin rays long, the posterior-most dorsal rays reaching past base of caudal when depressed. At 15–17 mm caudal fin notably longer than head, strongly pointed; at 60–65 mm caudal fin long and pointed, longest ray longer than head by at least diameter of eye; by 100 mm caudal fin with characteristic adult shape (upper lobe slightly concave, lower lobe rounded). At 15–17 mm pectoral fin reaches to anal fin origin; at 35–40 mm pectoral fin reaches only to tip of pelvic fin. At 15–17 mm pelvic spine well developed, fin reaches to or a little beyond anus; at 35–40 mm pelvic fin reaches anal fin origin. At 15–17 mm body depth 2.4 in TL, anus to caudal base 3.1 in TL; at 20–25 mm proportions similar to adult, depth 2.5 in SL; at 60–65 mm depth 2.6–2.8 in SL. At 15–17 mm maxillary reaches nearly to posterior margin of orbit; at 20–25 mm maxillary reaches to posterior margin of eye, 2.0–2.2 in head. At 15–17 mm scales present on most of body; by 20–25 mm body fully covered with scales. At 15–17 mm preopercular margin with small serrae and 3 long spines at angle (also evident in smaller specimens); at 20–25 mm preopercular margin strongly serrate, but spines at angle absent; at 35–40 mm serrations reduced but still stronger than in adult.[2]

Pigmentation: At 15–17 mm black pigment spots still more numerous; a concentration of spots suggesting a broad band present on side below base of spinous dorsal fin; black spots extend onto spinous dorsal; pelvic and pectoral fins mostly black; the ventral black spot at end of anal fin base absent in some. At 20–25 mm pigment has increased greatly; indications of 3 dark bars present, the first under spinous dorsal, broad and distinct, the second under end of anterior third of soft dorsal, the third under posterior third of soft dorsal, a concentration of dark chromatophores occurs near base of caudal fin,

Fig. 119. *Larimus fasciatus,* Banded drum. A. Juvenile, 17.0 mm. B. Juvenile, 24.0 mm. (*A, B, Hildebrand, S. F., and L. E. Cable, 1934: figs. 32–33.*)

forming a dark blotch; pelvic fin almost wholly black; inner surface of basal two-thirds of pectoral fin black. At 35–40 mm 7 dark crossbars present, the broad one under base of spinous dorsal shows indications of dividing into 2 narrower bars. At 60–65 mm adult color pattern fully developed; ground color silvery, back slightly brownish; sides with 7–9 dark bands; spinous dorsal, anal, pectoral, and pelvic fins largely dusky to black and other fins plain or somewhat punctulate with dusky.[2]

GROWTH

Fairly rapid, may reach 120–125 mm in first year, but average probably much smaller.[2]

AGE AND SIZE AT MATURITY

Females 170 mm TL full of eggs (LNC).

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Leiostomus xanthurus Lacépède, Spot

ADULTS

D. IX [25] to XI [1,16]–I, 29 [16]–35; [25] A. II, 12–13; [1,6,16] C. 9+8, procurrent rays 6–8+6–8; [1] V. I, 5; [12] scales 72–77 in a lateral series; [6] vertebrae 10+14 [16] or 10+15; [1,16] gill rakers 8–12+20–23; [25] branchiostegals 7; [12] teeth small, villiform, set in bands in jaws (LNC).

Head 2.9–3.6; depth 2.5–3.6 in SL; snout 2.7–3.4, eye 3.0–3.9, interorbital 3.0–3.8, maxillary 2.6–3.2, pectoral fin 0.9–1.4 in head.[6]

Body rather deep, compressed; back strongly elevated; head short, obtuse; snout blunt; mouth small,[6] inferior; maxillary reaching to about middle of eye; mandible with five pores at the tip (LNC). Scales rather small, ctenoid, extending onto base of caudal fin, small scales also present on base of other fins. Dorsal fin continuous, with a notch in between the spinous and soft portions (LNC); the spines slender, the third and fourth the longest; caudal fin notably concave, upper rays longest; pectoral fin long, reaching well beyond tip of pelvic fin.[6]

Pigmentation: Color bluish gray above with golden reflections below; sides with 12–15 oblique dark streaks (indistinct in very large specimens); a large black spot on shoulder (above the upper end of gill covers); fins generally pale to yellowish (LNC).

Recognized by comparatively short compressed body, short obtuse head, small horizontal mouth, oblique bars, and particularly the dark shoulder spot.[6]

Maximum size: Largest recorded 340 mm; apparently grow larger in northern parts of range.[4]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts Bay to Bay of Campeche.[8]

Area distribution: Widespread in Chesapeake Bay; [6] ocean coasts of Maryland [21] and Virginia; [14] Delaware; [13,15] Atlantic, Cape May, Monmouth and Ocean counties, New Jersey.[17]

Habitat and movements: Adults—taken most frequently over mud and sand bottoms [8,10] in inside waters and offshore to at least 132 m; chief fishery centered around area between Chesapeake Bay and North Carolina.[8] Atlantic and Gulf coast populations migrate offshore in fall [4,5,6,8,19,20] for spawning and to escape cold temperatures.[18] Taken in Chesapeake Bay April–November, mainly September–October; [6] taken on eastern shore of Virginia [14] May–September. Some evidence indicates do not return to bays after spawning, may not survive.[5] Euryhaline,[4,15] taken in salinities from 0–60 ppt; taken in temperatures from 6–36.7 C, lethal temperature near 5 C.[8]

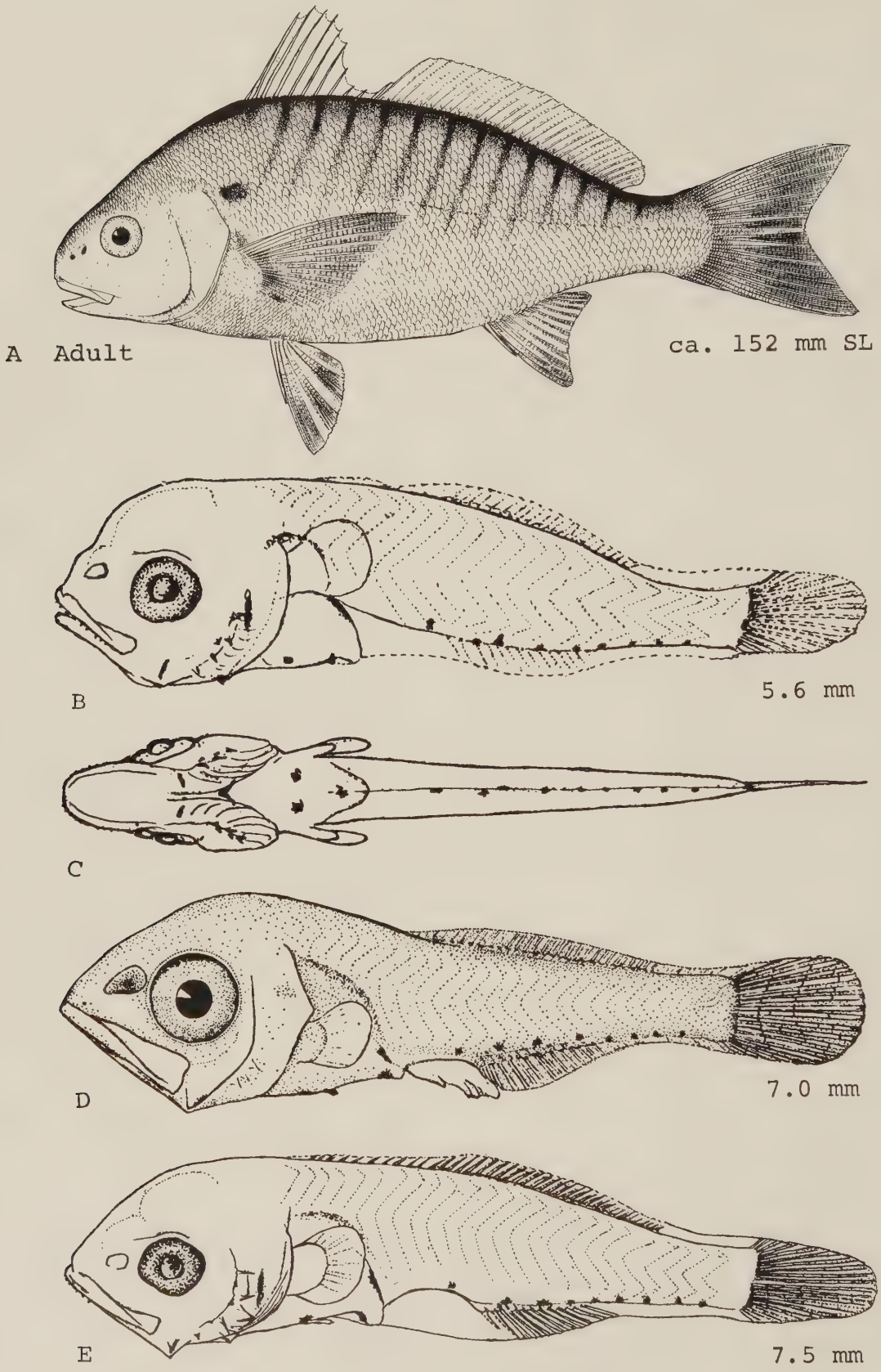
Larvae—at Beaufort taken in equal abundance in harbor and out to about 19–24 km offshore; may be present at any depth, but occur more frequently at bottom.[4]

Juveniles—enter estuarine nursery grounds at about 4 months.[24] In South Carolina most abundant in areas characterized by marsh, mud bottoms and reduced salinities, entering as early as February or March and continuing to enter as late as spring or early summer; probably remain until end of summer.[8] At Beaufort seen in schools along shores February–April, particularly in coves and around stone breakwaters and jetties; later, at about 25 mm and above, often become numerous in shallow water where vegetation abundant, remaining there throughout summer and far into winter (some apparently moving offshore); may ascend brackish water ditches to fresh water during spring and early summer.[4] Enter Chesapeake Bay in spring, remain until fall when migrate to sea, some overwinter in deeper bay waters.[9] Enter Mobile Bay January–March, dispersing into shallow and marsh areas until spring when they move into shallow open bay waters; at age 1 migrate offshore in winter (small individuals at age 2) and apparently never return to bay; older fish seem to prefer deeper water.[7] In Texas, tend to remain in shallower lagoons and coves until coming of cold weather when may move to deeper waters of bays and Gulf.[5] Individuals penetrating into marsh apparently part of much larger population which concentrates in nearby shallows of bays and Gulf; leave marsh at about 60 [11]–80 mm.[23] Taken in salinities from 0 [7]–34.2 ppt,[2] smaller specimens mostly taken below 4.9 ppt.[18] Taken in temperatures from 6.3 [7]–32.5 C; [2] temperatures of 4–5 C lethal,[8] but no ill effects observed on those taken in Mississippi at 5–9.9 C; [18] may be less sensitive to cold than adults.[4]

SPAWNING

Location: Occurs well offshore [6,7,8,9,10,11,24] in moderately deep water [7,8,11] with possibly some activity near beaches [10] or passes.[5,10]

Season: In Chesapeake area, late fall and winter; off North Carolina, October [8]–February, principally December–January; [4] off South Carolina, probably October–March, mostly December–January; [8] off Georgia, October–March, peak November–December; [10] off Florida, December–March; [2,11,23] off Alabama, probably from December to at least as late as February; [7] off Texas, late December–March, peak January–February.[5]


A Adult
ca. 152 mm SL
B
5.6 mm
C
D
7.0 mm
E
7.5 mm

Fecundity: Mature females probably produce 70,000–90,000 eggs; [8] ova of several sizes found in developed ovaries.[4]

EGGS

Undescribed, probably about 0.65–0.8 in diameter.[4]

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

Yolk completely absorbed in smallest examined, 1.5 mm.[4]

LARVAE

Described from 1.5 mm to 15.0 mm.

At 6.0 mm a thickening evident along part of dorsal finfold, rays becoming slightly evident; at 7.0 mm soft rays may be evident at bases but spines not evident; at 10.0 mm soft dorsal well developed except for a few posterior rays; at 15.0 mm anterior spines developing. At 6.0 mm a thickening evident at base of anal finfold; at 7.0 mm rays evident, at least at bases; at 10.0 mm full complement of spines and rays. At 3.6 mm rudimentary caudal fin rays evident; at 4.0 mm notochord beginning to flex in most, fin rays better defined; at 6.0 mm caudal fin fairly well formed, flexion complete; at 10.0 mm middle rays of caudal fin nearly all same length making posterior margin of fin straight.[4] Pectoral fin bud evident at hatching (HWP); at 7.0 mm pelvic fin just becoming evident; at 10.0 mm pectoral and pelvic fins with definitely differentiated rays. At 1.5 mm mouth well developed and oblique; at 10.0 mm mouth much less oblique and slightly inferior, distinct spines present on preopercle.[4]

Pigmentation: At 1.5 mm dark peritoneum visible above gas bladder; occasionally a row of dark chromatophores along ventral midline posterior to anus, one on middle of side above anus and a few on head. At 2.8 mm dark peritoneum more distinct as a crescent-shaped mark above abdominal cavity; an elongated dark chromatophore on dorsal surface of hind gut; a row of dark chromatophores present along ventral edge of entire caudal portion of body. By 3.6 mm [4] or smaller (HWP) a dark chromatophore present on mandible at juncture with quadrate, situated slightly behind middle of eye; a few small indefinite dark specks scattered over head.[4] At 4.0–15.5 mm SL a melanophore present on anterior surface of visceral mass, between the cleithra; a triangle on ventral abdomen formed by a pair of melanophores, one on each side of midline, midway between cleithral symphysis and anus (on ventral surface of visceral mass) and a single melanophore on ventral midline, just anterior to anus (HWP). At 7.0 mm dark spot on mandibular hinge still present; dark peritoneum still faintly visible through abdominal wall; a dark chromatophore remains at a point slightly in advance of anal origin; other pigment spots present along ventral midline (see below). At 15.0 mm pigment about same except black peritoneum less visible through body wall and a few dark markings on base of caudal.[4]

Distinguished from *Micropogonias undulatus* by presence of melanophore on anterior surface of visceral mass, between the cleithra (HWP), the 3 spot triangular pattern on ventral abdomen [16] (not always reliable,[16] described elsewhere as a 4 spot diamond [22]) and a continuous row of melanophores along the base of the anal fin (BWS). Distinguished from *Sciaenops ocellata* and *Pogonias cromis* by absence of dark markings along back and sides (appear later). Distinguished from *Bairdiella chrysoura* by lack of broad dark patch behind head and over abdomen.[16]

JUVENILES

Specimens described 20.0–50 mm.

At 20.0 mm dorsal fin with full complement of spines and rays. At 20.0 mm caudal fin distinctly concave. At 20 mm dorsal outline quite convex but not nearly so much as in adult, depth 3.8 in SL; at 25 mm body deeper, back higher, mouth less oblique and somewhat more inferior; at 30 mm preopercular spines considerably reduced or absent; at 50 mm essentially with form of adult, snout blunt, mouth horizontal, and inferior, back elevated and ventral outline straight, body deep, about 3.0 in SL. At 30 mm scales evident over most of body, forming first on sides of abdomen; lateral line largely developed.[4]

Pigmentation: At 25.0 mm dark chromatophore previously situated on sides in advance of anus, now absent; dark spots extending along ventral edge from origin of anal to caudal fin still present; row of vertically elongate dark spots on base of caudal fin more pronounced and additional chromatophores present around mouth, on head and in a row widely spaced along upper edge of back; a very small chromatophore present on median line of side of caudal peduncle, slightly in advance of caudal fin base and a few small dark points in same

Fig. 120. *Leiostomus xanthurus*, Spot. A. Adult, ca. 152 mm SL. B. Larva, 5.6 mm. C. Ventral view of A. D. Larva, 7.0 mm, head and eye inaccurately depicted, much too large in relation to body (HWP). E. Larva, 7.5 mm. (*A, Goode, G. B., 1884: pl. 124. B, C, E, Lippson, A. J., and R. L. Moran, 1974: 220. D, Hildebrand, S. F., and L. E. Cable, 1930: fig. 44.*) *The illustrations of the 1.7, 3.2, and 4.0 mm specimens of Hildebrand and Cable (1930) are not reproduced here as they show little resemblance to larvae of* L. xanthurus *(HWP).*

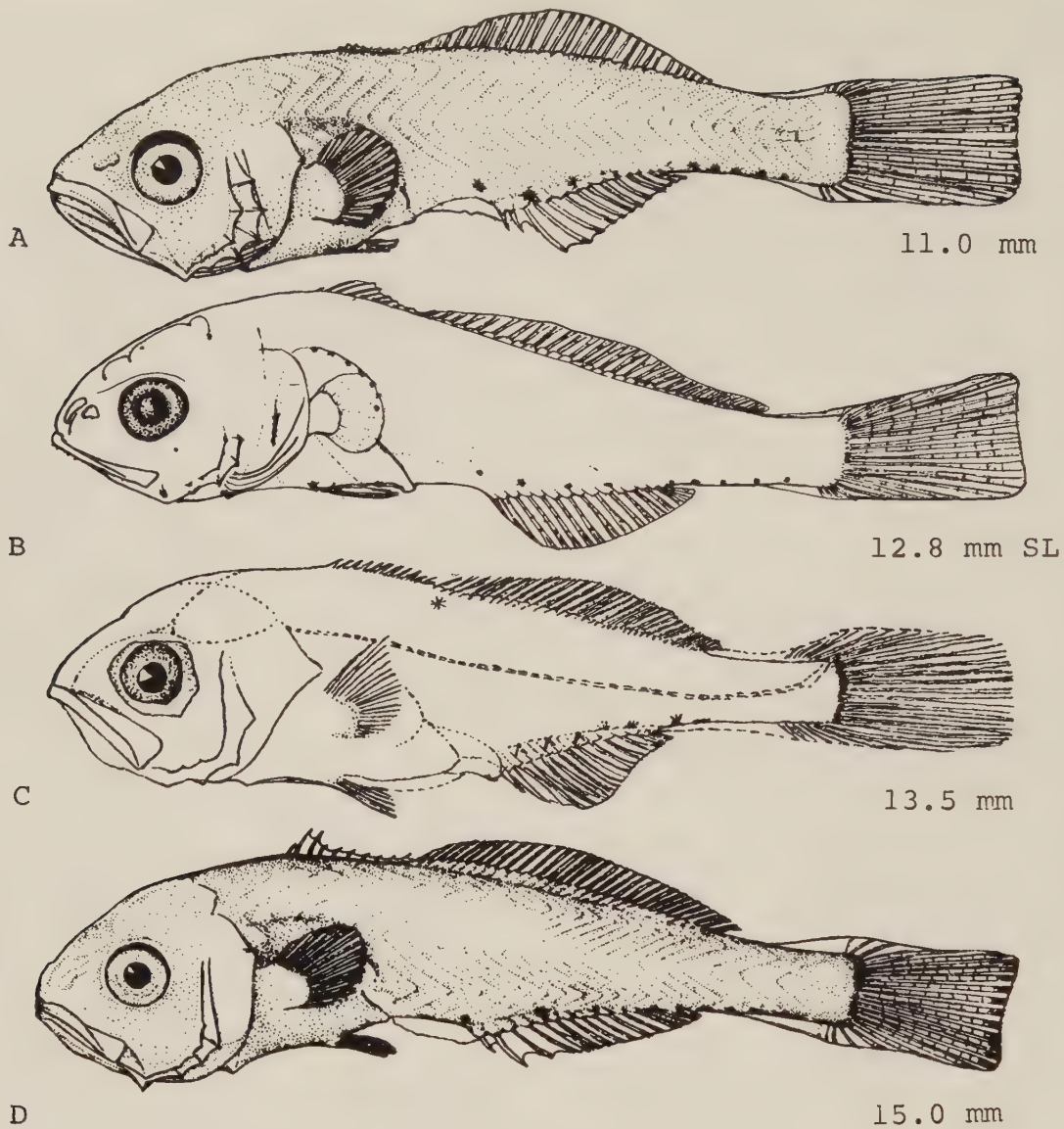


Fig. 121. *Leiostomus xanthurus*, Spot. A. Larva, 11.0 mm. B. Larva, 12.8 mm SL. C. Larva, 13.5 mm. D. Larva, 15.0 mm. (*A, D, Hildebrand, S. F., and L. E. Cable, 1930: figs. 45–46. B, Lippson, A. J., and R. L. Moran, 1974: 221. C, Pearson, J. C., 1929: fig. 40.*)

plane forward of it; dark spot at hinge of mandible persists; a prominent chromatophore on median line slightly behind isthmus and another at base of each pelvic fin; some variation in pattern and intensity. At 30.0 mm pigmentation developing rapidly; silvery on lower part of sides of head and body brownish (in alcohol) on back and upper parts of sides; body nearly everywhere marked with dark chromatophores which extend on all fins except pelvic; in most a row of dark blotches evident along median line of side, and faint saddle like blotches sometimes visible on back. At 50 mm dark oblique bars (generally yellow or brassy in life) present on back, as in adult, but less distinct; dark spot on shoulder faintly visible.[4]

At 50 mm recognizable by adult characters: comparatively short, compressed body; high back; short obtuse head; small horizontal mouth; concave margin of caudal fin; oblique bars and dark shoulder spot.[4]

GROWTH

Various estimates of yearly growth as indicated by age-length relationship (Table 2, modified from Dawson, 1958 [8]):

Modal lengths during first year in Georgia: February-March, 23 mm; April, 43 mm; May, 63 mm; June, 98 mm; July, 113 mm; August, 128 mm; September, 138 mm;

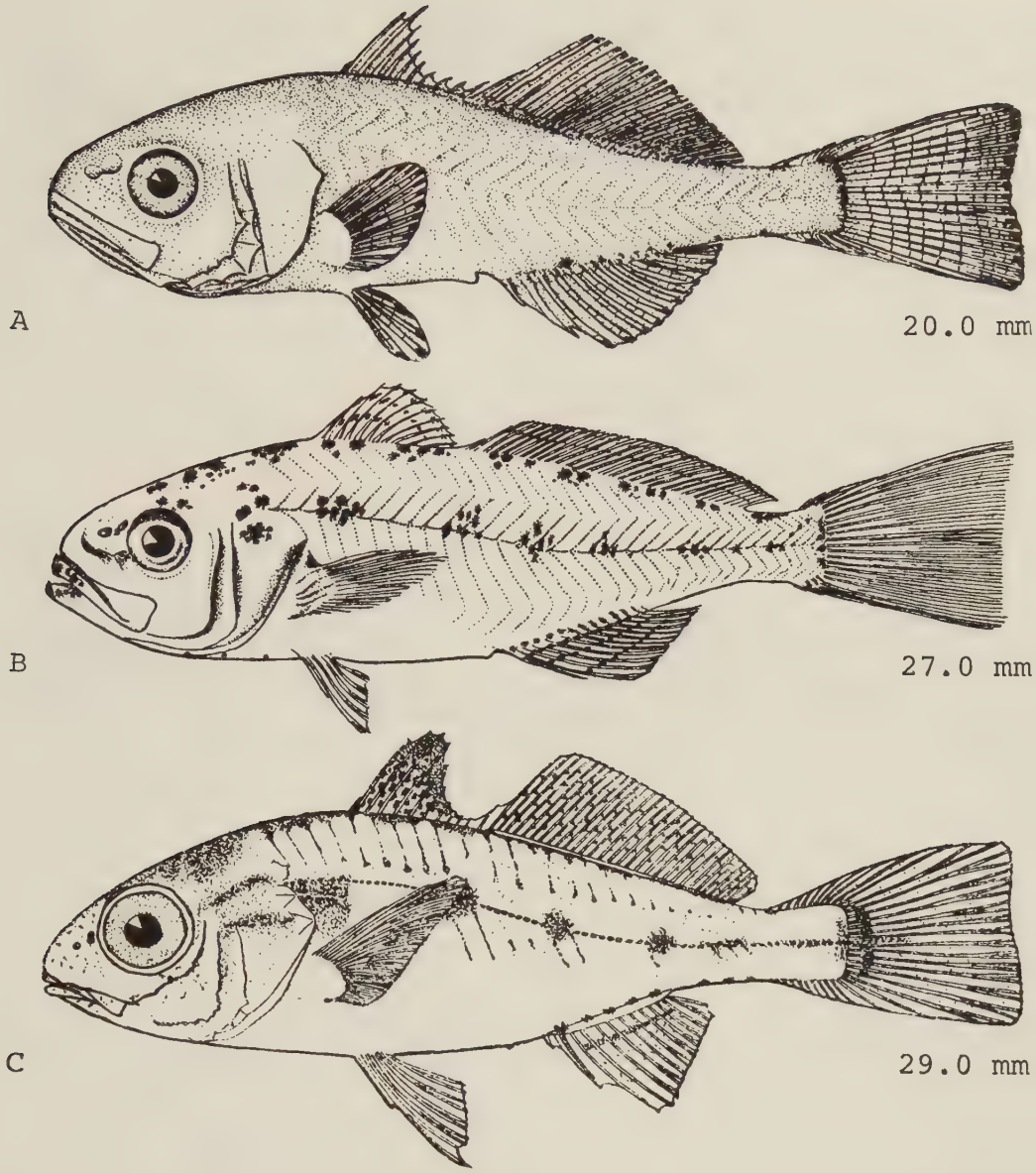


Fig. 122. *Leiostomus xanthurus*, Spot. A. Juvenile, 20.0 mm. B. Juvenile, 27.0 mm. C. Juvenile, 29.0 mm. (*A, Hildebrand, S. F., and L. E. Cable, 1930: fig. 47. B, Hildebrand, S. F., and W. C. Schroeder, 1928: fig. 156. C, Pearson, J. C., 1929: fig. 41.*)

ctober, 143 mm.[10] Average lengths during first year at eaufort: January, 12.6 mm; February, 18.5 mm; March, .3 mm; April, 29.8 mm; May, 45.8 mm.[4]

GE AND SIZE AT MATURITY

lature at end of second year [4,5,7,8,11] or early in third ear.[8] Ripening individuals taken in Texas 170–210 mm; [5] so in Texas a number of ripening, ripe and spent dividuals taken from about 200–275 mm.[19]

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Fig. 123. *Leiostomus xanthurus*, Spot. A. Juvenile, 30.0 mm. B. Juvenile, 46.0 mm. (*Hildebrand, S. F., and L. E. Cable, 1930: figs. 48–49.*)

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TABLE 2.—Growth of *Leiostomus xanthurus*

Method	Area	SL in mm at age: I	II	III	Other
Scales	New Jersey [3]	63.3–79.5	132.6–176.9	193.1–233.5	241.7 at 4.5 years.
Length–frequency	Chesapeake Bay [6]	101.4			
Length–frequency	Chesapeake Bay [9]	ca. 170 mm	ca. 220 mm		
Length–frequency	Beaufort [4]	111.9			152.5–160.7 at 16 to 17 months.
Length–frequency	Fernandina, Florida [3]	111.9			
Scales and length–frequency	Alligator Harbor, Florida	95–129	150–185		60–95 at 6 months; 105–145 at 16 months.
Length–frequency	Texas [5]	103.8–111.9	152.5–168.7		

Menticirrhus americanus (Linnaeus), Southern kingfish

ADULTS

D. IX or X [5] (usually X [7,10])–I, 20–26 ($\bar{x}$ 23.9 [5]); A. I [5,6,7] (Miller and Jorgenson, 1973, report II [10]), 6–8 [5] (usually 7 [5,6,7]); C. 9+8, procurrent rays 8–9+7; [10] P. 18–24 (usually 20 or more [5]); V. I, 5; [7] vertical scale rows above lateral line 62–92; [5] vertebrae 10+15; [10] gill rakers tuberculate (2–3+0–7) [20] or absent; [5] branchiostegals 7; [7] teeth small, villiform, set in bands, outer row of upper jaw slightly enlarged, lower jaw teeth subequal (LNC); no molariform teeth on pharyngeal plates.[5]

Head 3.1–3.9, depth 3.6 [6]–5.0 [7] in SL; snout 3.1–4.1, eye 2.8–6.5, interorbital 3.1–4.4, maxillary 2.5–2.9, pectoral fin 1.0–1.5 in head.[6]

Body elongate, rounded; back elevated; [6] ventral side flat (LNC); head low; snout conical, projecting beyond mouth; mouth horizontal, inferior; chin with a single short barbel [6] and perforated by an apical pore and with 4 lateral pores (LNC); maxillary reaching below middle of eye. Dorsal fin continuous, with a deep notch between spinous and soft portions, the spines slender, flexible, non-produced, the third the longest; [6] in specimens larger than 200 mm dorsal spines seldom extending past base of first dorsal soft ray when depressed; [5] soft dorsal fin rather long and low; caudal fin with concave upper lobe and produced, pointed lower lobe, this lobe proportionately longer in larger specimens; anal fin short; pectoral fin reaching to or beyond tip of pelvic.[6]

Pigmentation: Color generally grayish or tan above (LNC) with obscure lateral bars and varying amounts of lighter pigment (white or silvery) on breast and belly, fresh specimens with silvery reflections; overall darkness variable with habitat—in surf light and silvery, the lateral bars almost invisible, usually dark brown in deeper water; in life sometimes with yellowish pigment on pelvic, anal, and caudal fins, these fins dusky or dark brown in fresh specimens; spinous dorsal dusky,[5] the membrane in some edged with black from first to sixth or seventh spine; soft dorsal plain, some of rays tipped with black; anal and pelvic fins white, faintly marked with light brown; pectoral fin dusky or black, especially at tip; lower lobe of caudal fin darker than upper in most. Lateral bars as follows: Usually a darkened area on nape followed by a patch of lighter pigment around origin of spinous dorsal; posterior to origin of spinous dorsal are 6 oblique bars running anteriorly and ventrally from dorsum; [6] bars broad, about 2 times eye diameter (LNC); first bar extending from middle of spinous dorsal toward opercular spines; second extending from posterior part of spinous dorsal to a dark blotch near pectoral axil; third, fourth, and fifth extending from dashes along base of soft dorsal to blotches of pigment below lateral line; sixth consists of a saddle or dash of pigment on caudal peduncle and a blotch of dark pigment below it which sometimes run together; second bar usually the most distinct, others often broken up into blotches and dashes; in some, dark bars wanting and belly may be plain white; [6] inside of gill cover very dark.[5]

Distinguished from *M. saxatilis* by plainer coloration, typically 7 anal rays, lower spinous dorsal and larger scales. Distinguished from *M. littoralis* by breast scales of uniform size,[6] pectoral fin which reaches to or beyond tip of pelvic fin, and presence of obscure bars and blotches on sides and back.[4]

Maximum size: Largest recorded 419 mm, 1.1 kg.[6]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Long Island, New York [19] to Buenos Aires, Argentina including the West Indies (as *M. martinicensis*); common from Chesapeake Bay to Fort Pierce, Florida and in Gulf of Mexico from Cape Sable, Florida to Campeche, Mexico; common in trawls off British Honduras and along beaches of Brazil.[5]

Area distribution: Chesapeake Bay at St. George Island and Solomons Island, Maryland, and Cape Charles City and Ocean View, Virginia; [6] outer coast of Virginia in Sand Shoal Inlet Channel; [13] Atlantic and Ocean counties, New Jersey.[11]

Habitat and movements: Adults—primarily bottom dwelling; [4] taken nearshore on outside of barrier islands or in deeper water (9–36 m), deepest record about 67 m; [5] found on mud, sand, mud-sand mixtures, and mud-shell mixtures, but prefer clear sandy bottoms along beaches and near mouths of coastal sounds.[1] In western Gulf of Mexico, more common than *Micropogonias undulatus* at about 56–67 m.[12] In South Carolina most numerous in fall following spawning, when they move into sounds and often up into tidal rivers.[1] In temperate areas move offshore to deeper water in cold weather.[1,9,12] Fairly common in shallow water at Cedar Key, April–December.[18] Euryhaline; taken in salinities from 6.4–41 ppt, most common above 24 [5]–30 ppt.[6] Taken at temperatures below 6 C; in South Carolina major portion of inshore population moves offshore to deeper waters during winter when temperatures fall below 10 C.[1]

Larvae—specimens 1.5–7 mm taken in lower Chesapeake Bay June, July and September; [15] 15 of 18 specimens below 5 mm taken along outside shores at Beaufort.[4] May be transported far up tidal rivers by high salinity bottom currents during first few weeks of life, then actively move to higher salinity areas as fish grows.[1]

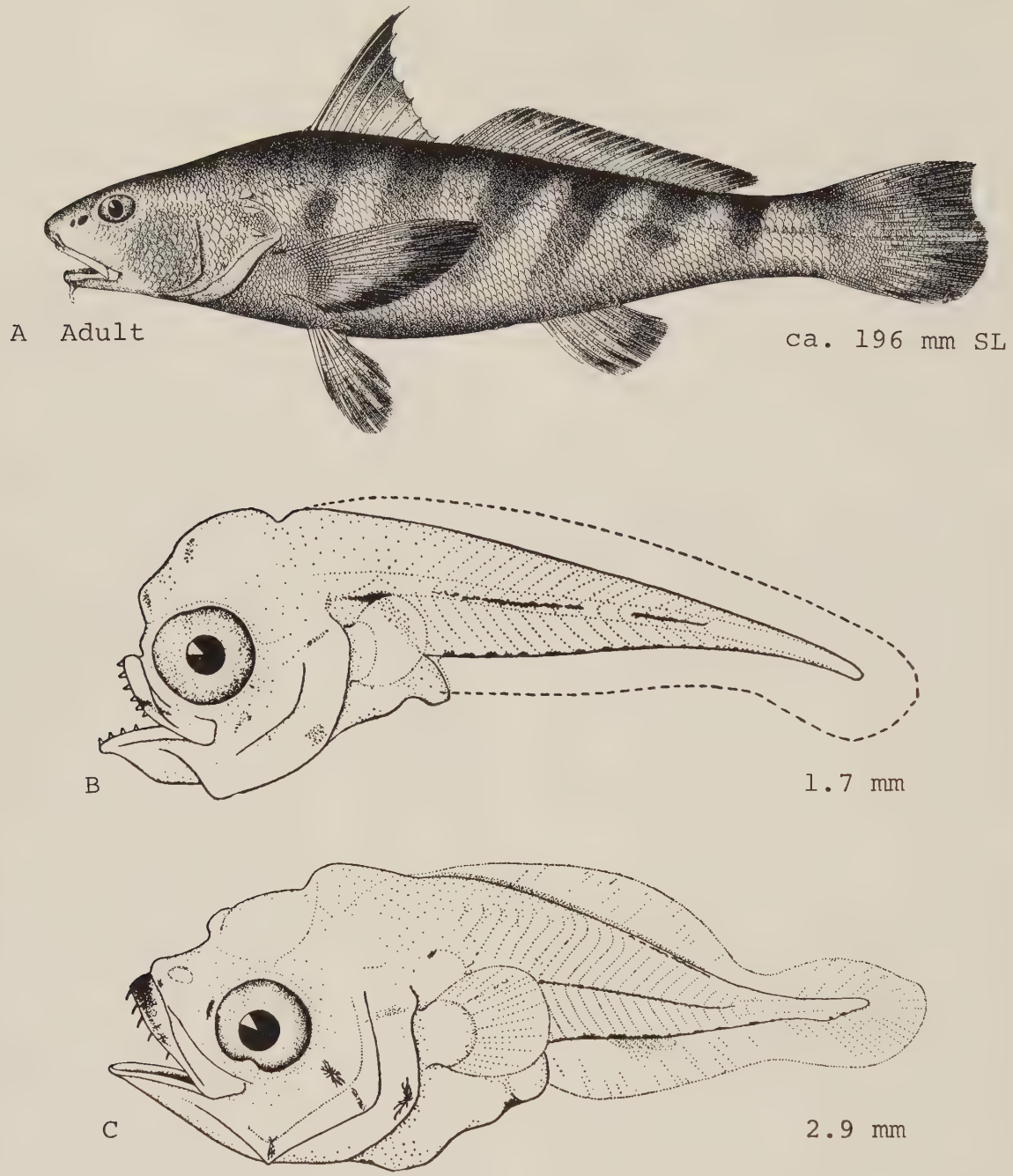

Fig. 124. *Menticirrhus americanus,* Southern kingfish. A. Adult, ca. 196 mm SL. B. Larva, 1.7 mm. C. Larva, 2.9 mm. (*A, Goode, G. B., 1884: pl. 127A. B, C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 1–2.*) *Figs. B and C questionable, could be* Cynoscion nebulosus (*HWP*).

Juveniles—primarily bottom dwelling [4] over soft mud and decaying vegetation.[1] Spend first summer in shallow water habitats, including open outer beaches, estuaries, tidal rivers, passes, and river mouths; found in brackish bays and protected waters more often than other Atlantic species of *Menticirrhus,* but most common habitat for specimens less than 50 mm is open surf on sandy beaches; at 50–150 mm most often found in estuaries or inshore, but some taken at depths of up to 18 m; apparently gradually move toward ocean as mature.[1] Smallest specimens (less than 25 mm) taken July–August off Texas,[16] May, June and September off Louisiana,[5] and as late as November in Mississippi [8] and North Carolina; [4] taken year round in Everglades except early

vinter.[2] Taken at salinities from 1.9[5]–35.1[17] ppt and emperatures from 10[18]–32.5 C.[8]

SPAWNING

Location: Occurs largely or entirely offshore[1,4,5,15] in –36 m.[5]

Season: Spring and early summer in Chesapeake Bay,[6] arvae taken June and July to September;[15] April–August n North Carolina[4] and South Carolina with peak in une and July;[1] May–June in Tampa Bay area;[17] some ndication of 2 spawning seasons (spring and fall) in Florida,[3] but may be just one prolonged season;[4] prob- bly almost year round in Everglades, starting mid- to ate winter and reaching peak in spring;[2] in Gulf of Mexico may extend from as early as fall[3,14] through pring.[14]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

Smallest specimens examined 1.7 mm.

Note: *The 5.8 mm specimen described by Hildebrand nd Cable (1934) is in no way characteristic of this spe- ies and is not included here.*

At 3.8 mm soft dorsal and anal fin rays evident. First ndication of caudal fin rays at 3.6 mm (HWP); at 3.8 nm notochord flexed and caudal fin partly developed vith some rays. Pectoral bud prominent at 2.9 mm; at 3.8 mm pectoral short and broad with some indication of ays. Pelvic fin not evident at 3.8 mm. At 1.7 mm head nd body rather robust, somewhat compressed, greatest lepth only a little less than length of body to anus; anus omewhat in advance of midbody. At 2.9 mm body very leep, somewhat compressed, with abruptly tapering tail; lepth only slightly less than length of body to anus,[4] bout 35% SL (HWP); anus notably nearer tip of noto- hord than tip of snout. At 3.8 mm body deep and com- pressed; tail proportionately much deeper and less harply tapering; depth only about two-thirds length of ody to anus.[4] At 1.7 mm total myomeres about 25 (HWP). Prominent teeth present in jaws at 1.7 mm; eeth apparently smaller at 2.9 mm. Mouth strongly oblique at 1.7 mm, becoming gradually more horizontal with development.[4]

Pigmentation: At 1.7 mm color mostly pale with dark specks around mouth; dark specks also present along most of ventral outline and midline of tail where they form 2 dark longitudinal lines.[4]

At 2.9–3.8 mm general color pale with faint spots around mouth and along ventral outline of abdomen; the 2 longitudinal black stripes, along lateral midline and ventral outline now prominent on anterior two-thirds of tail; several minute dark dots form an indefinite line on dorsal outline of anterior part of tail.[4]

Most easily confused with *Cynoscion nebulosus,* from which it may be distinguished as follows:

Menticirrhus americanus—midlateral pigment line relatively short, extending from position of anus approximately to between soft dorsal and anal fin insertions (HWP); only internal pigment along midlateral line consists of extensions internally from midlateral dashes; caudal melanophores slightly branched but more concentrated in appearance; at 8 mm SL and larger many regular branched melanophores giving sides a uniform, dusky color; deeper bodied at comparable sizes (BWS).

Cynoscion nebulosus—midlateral pigment line relatively longer, extending from anterior to anus to insertion of soft dorsal fin (HWP); internal pigment dorsal (sometimes 2 rows), lateral and ventral to caudal vertebrae; most caudal melanophores considerably branched; at 8 mm SL and larger dorsal, midlateral and ventral lines of pigment still evident; shallower bodied at comparable sizes (BWS).

JUVENILES

All fins with full complement of rays by 5[15]–8 mm.[4]

At 8 mm caudal fin produced and pointed, longest rays as long as head; at 10 mm nearly symmetrical and quite pointed; at 18–20 mm the longest rays definitely occurring in lower half of fin and somewhat longer than head;[4] lower lobe longer than upper lobe until about 200 mm.[5] At 8 mm pectoral fin reaches anus;[4] in specimens smaller than 70 mm, pectoral fin does not reach tip of pelvic fin; in specimens larger than 100 mm pectoral fin reaches tip of pelvic fin.[5] At 8 mm body proportionately more slender, but still compressed; head much broader; depth 3.0 in SL. At 10 mm depth 3.6–3.8 in SL, head moderately compressed, 2.7–3.1 in SL; eye a little longer than snout, pupil round; mouth moderately oblique, upper jaw now projecting beyond lower; longest dorsal spine reaches only slightly past origin of second dorsal when depressed. At 13–15 mm body less strongly compressed, but depth still about same; head less compressed; mouth more nearly horizontal; snout now projecting slightly beyond upper jaw. At 18–20 mm body more elongate and rounded, depth 3.6–3.8 in SL; head

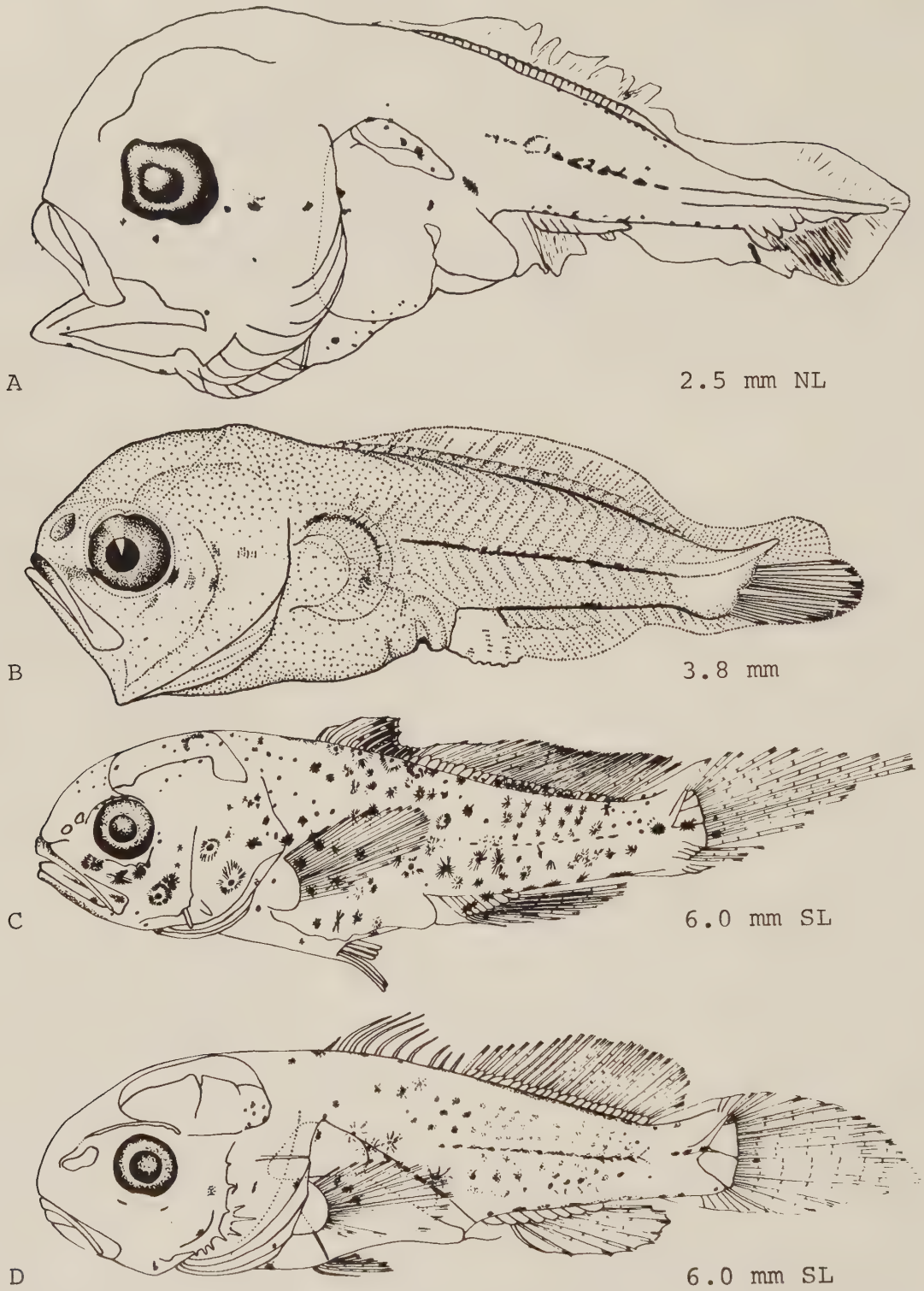

Fig. 125. *Menticirrhus americanus,* Southern kingfish. A. Larva, 2.5 mm NL. B. Larva, 3.8 mm. C. Larva, 6.0 mm SL. D. Larva, 6.0 mm SL. (*A, C, D, Jannke, I. E., 1971: fig. 21. B, Hildebrand, S. F., and L. E. Cable, 1934: fig. 3.*)

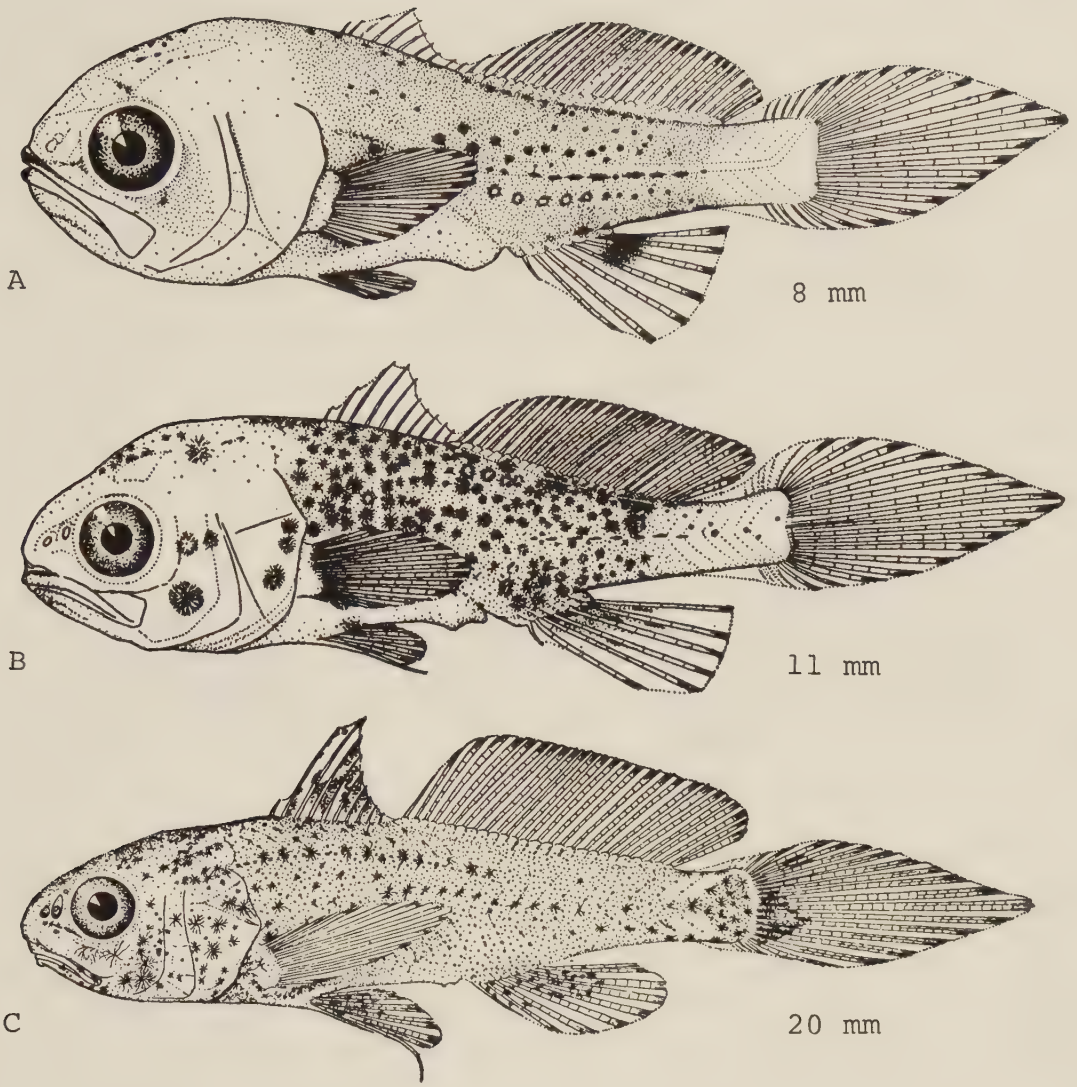

Fig. 126. *Menticirrhus americanus,* Southern kingfish. A. Juvenile, 8 mm. B. Juvenile, 11 mm. C. Juvenile, 20 mm. (*Hildebrand, S. F., and L. E. Cable, 1934: figs. 5–7.*)

till somewhat deeper than wide; mouth nearly horizontal and inferior; snout conical and projecting, only a little shorter than eye. At 30–35 mm body more rounded anteriorly; depth 3.8–4.0 in SL about as in adult; mouth inferior and horizontal; snout prominently projecting; none of dorsal spines produced and longest spines reach only to origin of soft dorsal when depressed. At 50–60 mm shape of adult essentially attained; snout more sharply conical and more prominently projecting, now subequal to eye; spinous dorsal quite pointed, but none of spines especially produced. Caudal fin does not attain adult shape (a slightly concave upper lobe and moderately short, sharply rounded lower lobe) until about 100 mm. Scalation nearly complete at 18–20 mm, complete by 30–35 mm. At 27–50 mm gill rakers on lower limb 0–7 (average 4.6); at 50–100 mm, 0–7 (average 2.8); in specimens larger than 100 mm absent or tuberculate.[5] At 18–20 mm mandibular barbel present as a slight knob at tip of lower jaw; at 30–35 mm still present as a knob; at 50–60 mm barbel about half as long as pupil.[4]

Pigmentation: At 8 mm lateral surface of body between visceral mass and caudal peduncle largely spotted with dark chromatophores, a few present on head and nape; dusky pigment around mouth and across mandibular symphysis; distal portion of tail remains pale and more or less transparent; slight dark coloration present on anal fin and margin of spinous dorsal. At 10 mm dark chromatophores almost everywhere, except on ventral surface, most numerous on side from opercular margin to end of anal base and few on head and caudal peduncle; spinous dorsal and anal fins usually partly black; caudal fin with at most a few dark points on base, other

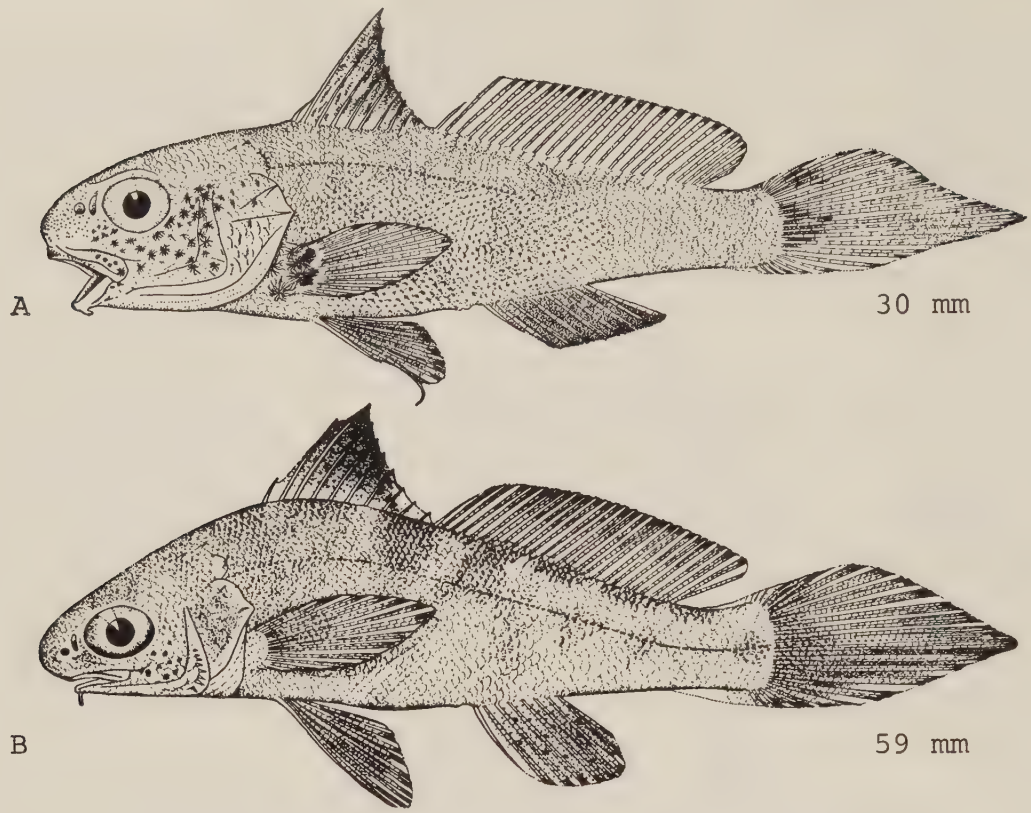

Fig. 127. *Menticirrhus americanus,* Southern kingfish. A. Juvenile, 30 mm. B. Juvenile, 59 mm. (*Hildebrand, S. F., and L. E. Cable, 1934: figs. 8, 9.*)

fins colorless. At 13–15 mm pigmentation about same; a general tendency toward fewer large branching chromatophores and more numerous small dark points; spinous dorsal and anal fin at least partly black; soft dorsal, pectoral, and caudal fins unmarked, or caudal with a few dark markings on base or solid black at base. At 18–20 mm entire body usually spotted with black or dark brown; spinous dorsal and anal fins largely black; pelvic fin with dark spots; generally 2 dark blotches on base of caudal fin.[4] At 20–30 mm general ground color of body and head silvery, with brownish chromatophores forming a pattern of cloudy bands similar to adult; membrane of spinous dorsal sparsely punctulate with brown; membrane of soft dorsal and anal fin with group of dusky punctulations basally at about middle of fin; pectoral fin hyaline; pelvic fin white with a few dusky punctulations on membrane; caudal fin hyaline, with a group of dusky chromatophores at base of median rays.[3] At 30–35 mm body fully pigmented, some much darker than others; lower parts generally silvery and upper parts brownish; ground color overlaid with irregular dark specks or spots which more or less follow rows of scales; some specimens with dark blotches, others with suggestions of dark crossbars; spinous dorsal largely black; a large black spot generally present on caudal base, preceded by a pale crossline, rest of fin plain translucent; anal and pelvic fin usually dusky to black and pectoral fin generally plain translucent or sometimes with dusky points. At 50–60 mm some retain indefinite dark blotches on sides, others with more or less definite oblique bars;[4] membrane of soft dorsal fin punctulate basally for entire length;[3] base of caudal dusky in most, extending onto lower lobe of fin; anal and pelvic fins partly white, as in adult.[4] At 80–135 mm spinous dorsal slightly dusky; soft dorsal nearly plain, sometimes slightly dusky, in one specimen tinged with yellow brown; caudal fin slightly dusky, tinged with yellowish brown; anal, pelvic, and pectoral fins slightly dusky, sometimes white, tinged with yellowish brown.[6]

At 10–15 mm distinguished from *M. saxatilis* and *M. littoralis* as follows: Body deeper and more strongly compressed anteriorly (especially head) than in *littoralis,* less so than in *saxatilis;* pupil almost perfectly round, whereas elliptical in other 2 species; caudal fin long and pointed and nearly symmetrical, whereas in other 2 species it is quite broadly and assymmetrically rounded, the longest rays being in lower lobe; spinous dorsal often partly black and pelvic fin colorless (or at most with a few dark points), while in *saxatilis* these 2 fins are

vholly black, and in *littoralis* they are colorless. At 30–35 nm distinguished from other 2 species as follows: pupil till round and caudal fin long and pointed; pectoral onger and scales larger (and not notably reduced on hest) than in *littoralis;* body more elongate than *saxa-ilis.* By 50–60 mm distinguished from other 2 species by same characters as adults.[4]

GROWTH

n New Jersey reach about 40 mm by first winter, about 60 mm by second winter, about 250 mm by third win-er; [3] at Beaufort average 116 mm by end of first sum-ner, 135 mm by November; [4] in South Carolina average 00 mm SL, 150–160 mm SL by following summer, 220–30 mm SL by third summer; [1] in Tampa Bay area speci-nens as small as 25 mm in July may reach 117 mm by October.[17]

AGE AND SIZE AT MATURITY

Males mature at about 2 years or a little less at a size of about 195 mm; females mature at 2 or 3 years at a ize of about 230–250 mm,[1] however one ripe female, 218 mm, taken.[5]

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Menticirrhus littoralis (Holbrook), Gulf kingfish

ADULTS

D. IX or X [13] (usually X [5,6,10,13])–I,[5,6,10,13] 19–26 ($\bar{x}$ 24 [13]); A. I [5,6,13] (Miller and Jorgenson, 1973, report II [10]), 6–8 [13] (usually 7 [6,10,13]); C. 9+8, procurrent rays 7–8+6; [10] P. 18–21 (usually 19 [13]); V. I, 5; [6] 63–81 (more typically 67–77) vertical scale rows above lateral line; [13] vertebrae 10+15; [10,13] gill rakers 3–5+0–8,[14] those on lower limb 0–6 (average 4.0) in specimens 200–250 mm, 0–8 (average 3.9) in specimens 250–300 mm, 0–5 (average 2.7) in specimens 300–331 mm; [13] branchiostegals 7; [6] teeth in jaws small, villiform, set in bands, none especially enlarged; [5] lower pharyngeals with molariform teeth.[6,13]

Head 3.4–3.7, depth 3.6–4.3 in SL; snout 2.9–3.2, eye 3.1–4.1, interorbital 3.6–4.7, maxillary 2.6–3.0, pectoral fin 1.3–1.5 in head.[5]

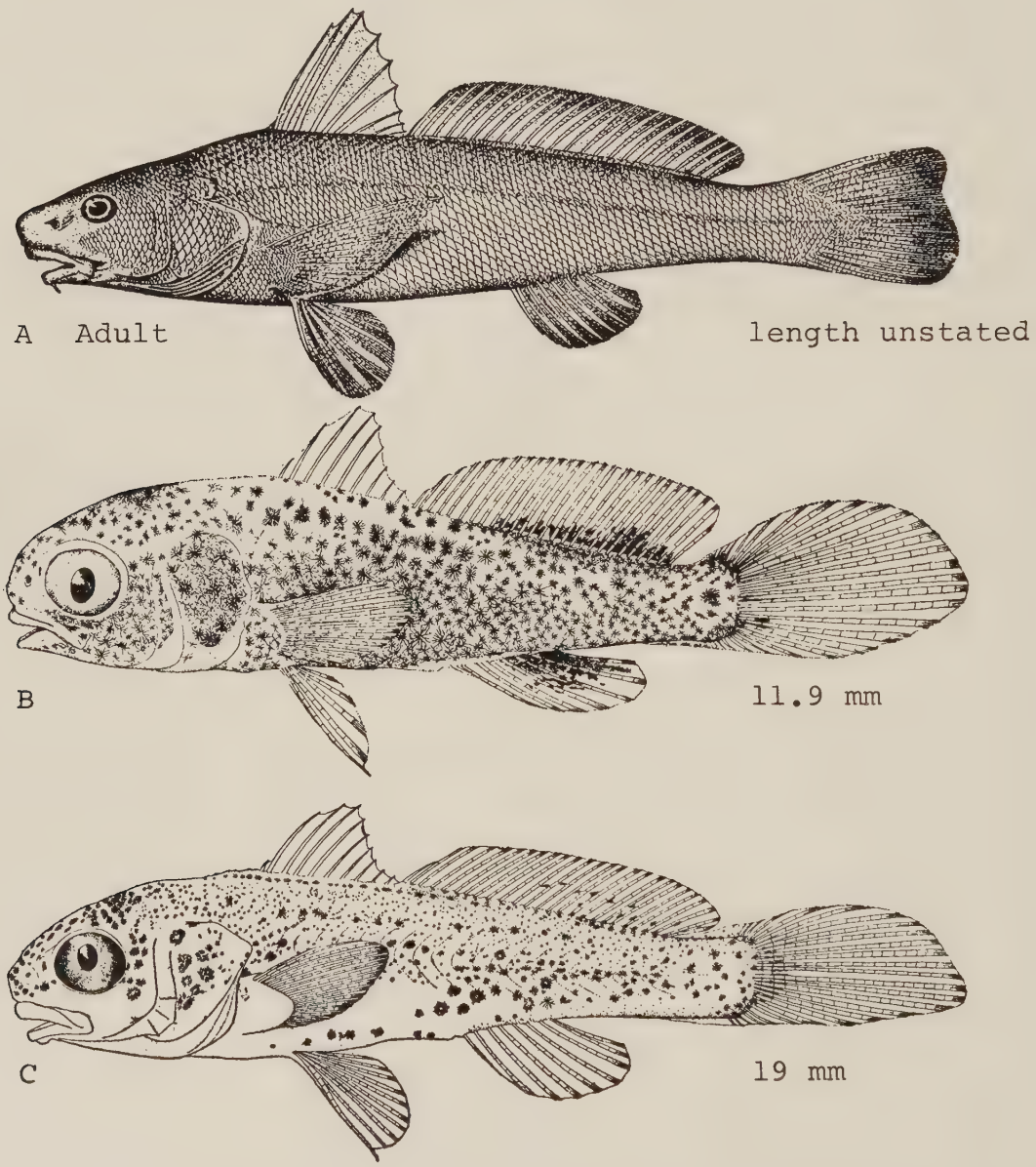

Fig. 128. *Menticirrhus littoralis*, Gulf kingfish. A. Adult, length unstated. B. Juvenile, 11.9 mm. C. Juvenile, 19 mm. (*A, Hildebrand, S. F., and W. C. Schroeder, 1928: fig. 172. B, C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 15–16.*)

Body elongate, rounded; back elevated;[5] ventral side rather flat (LNC); head low, snout conical, projecting beyond mouth; mouth horizontal, inferior;[5] chin with a single short barbel and perforated by an apical pore and with four lateral pores (LNC); maxillary reaching below middle of eye. Scales rather large, strongly ctenoid,[5] breast scales near head much smaller than those along lateral line.[13] Dorsal fin continuous,[5] with a notch between the spinous and soft portions (LNC); spinous dorsal, when depressed usually falling between first and second soft rays,[13] the spines slender, flexible, none produced; soft dorsal long and low; caudal with concave upper lobe and pointed lower lobe, this being more pronounced in smaller specimens; anal fin small; pelvic fin moderate, inserted one-half eye diameter behind pectoral in base; pectoral fin short, not reaching tip of pelvic fin. Preopercle serrate.[5]

Pigmentation: Silvery gray above with bluish and bronze reflections, immaculate; a dark bronze shade along sides at level of pectoral fin, extending to tail and along cheeks; belly below this abruptly white; dorsal fin light brown, spinous dorsal black at tip, the base narrowly white; caudal fin pale, its tip usually black; inner lining of pectoral and pelvic fins blackish; gill cavity pale.[6]

Readily separable from other species of *Menticirrhus* by larger body scales, greatly reduced scales on chest, relatively short pectorals,[5] low dorsal spines, short anal fin characteristically with 7 soft rays, and the plain silvery gray coloration.[3]

Maximum size: Reported to reach 457 mm.[13]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Delaware[12] to Brazil[11,13] and throughout the Gulf of Mexico;[11] most common south of Cape Hatteras on Atlantic Coast and in Gulf of Mexico.[13]

Area distribution: Chesapeake Bay at Ocean View, Lynnhaven Roads,[5] Buckroe Beach,[5,13] and Norfolk, Virginia;[13] Rehoboth Beach, Delaware.[12]

Habitat and movements: Adults—almost always found in shallow open surf over sandy bottom[1,4,8,13] or in less than 36 m of water just offshore,[13] rarely taken in inside waters.[1,13] In Texas taken in Aransas Bay, May, July, October, on Gulf beaches, June–October, February and March, and trawled from the Gulf in November and January;[4] apparently move to slightly deeper waters in winter.[13] Taken in Aransas Bay in salinities from 17.9–36.7 ppt, but rarely taken below 25 ppt;[4] never taken in South Carolina below 25 ppt;[1] taken in Laguna Madre in up to 45 ppt.[7] Taken in Aransas Bay from 13.8–30.6 C;[4] taken in South Carolina only above 20 C.[1]

Larvae—no information.

Juveniles—taken only in open surf; widely distributed in South Carolina along sandy beaches of open ocean coasts and near mouths of sounds during summer and fall;[1] specimens less than 50 mm swim within centimeters of waters edge in open surf.[13] Specimens 15–120 mm common at Beaufort during summer in surf along outer shores of banks;[3] specimens 22–26 mm taken June–October in Texas;[4] specimens 132–180 mm taken February–April in about 5 m in Texas.[9] Taken in Tampa Bay in salinities from 31.8–35.1 ppt and temperatures from 10.8–31.0 C.[8]

SPAWNING

Location: Occurs in open outside waters.[3]

Season: In North Carolina begins at least by first of May and continues to as late as mid-September,[5] probably about same for South Carolina;[1] occurs May–August in Texas;[4] ripe or spent adults taken April in northern Gulf of Mexico, June in North Carolina and Texas, and May in Florida;[13] April to September in Georgia.[15]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Smallest examined 9–10 mm.

At 10 mm all fins with full complement of rays; longest dorsal spines reach beyond first dorsal soft rays. At 10 mm caudal fin asymmetrically rounded, the longest rays in lower lobe.[3] At 38–51 mm pelvic fin reaches beyond anus, second and third rays longest (first ray longest in other species).[2] At 10 mm body quite elongate, compressed, body depth 3.6–4.0, head about 3.2 in SL; mouth moderately large and oblique; eye longer than snout; interorbital flat and broad. By 18–20 mm body slightly more rounded and elongate, depth 3.7–4.2 in SL; head only a little deeper than wide; mouth nearly horizontal and inferior; snout rather conical, projecting slightly. At 30–35 mm body with essentially adult form,

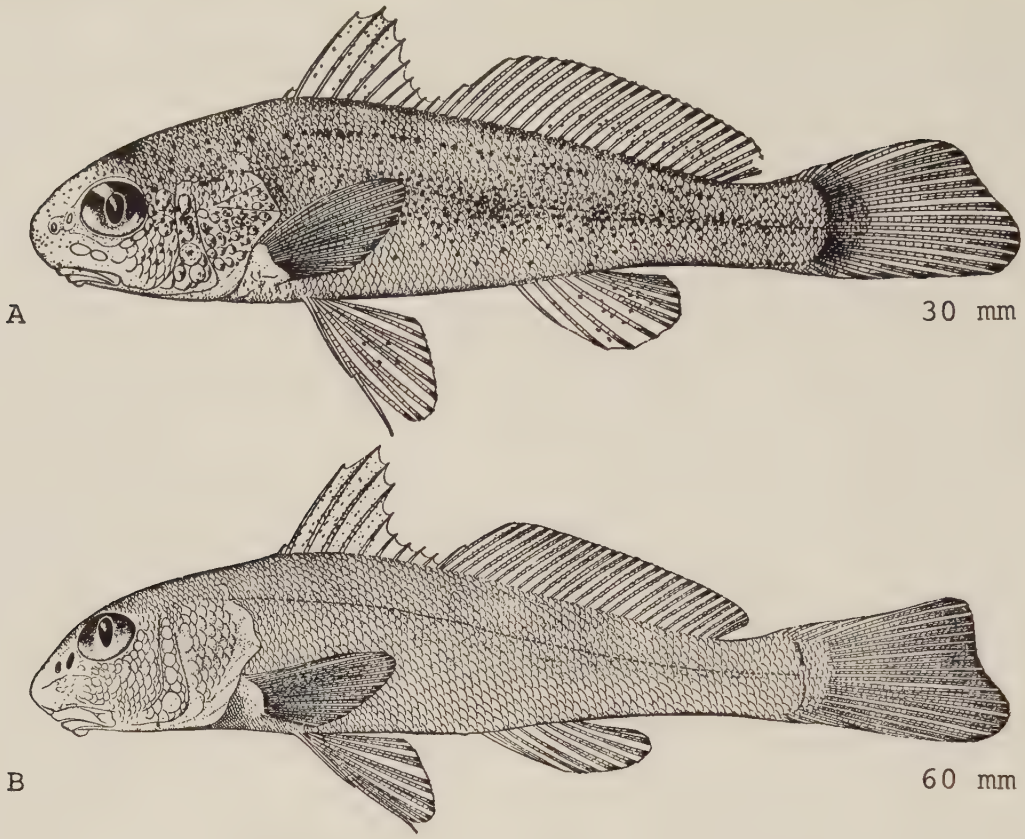

Fig. 129. *Menticirrhus littoralis,* Gulf kingfish. A. Juvenile, 30 mm. B. Juvenile, 60 mm. (*Hildebrand, S. F., and L. E. Cable, 1934: figs. 17–18.*)

depth 4.0–4.3 in SL; caudal fin slightly angular and longest rays (which are in lower lobe) notably shorter than head; pectoral fin falling an eye diameter short of tip of pelvic fin; pelvic fin not reaching anus.[3] At 38–51 mm body less compressed and less deep than *M. saxatilis* and *M. americanus.* In specimens less than 100 mm depressed spinous dorsal seldom reaches past first soft ray; in specimens 100–300 mm usually falls between first and second. Tip of pectoral fin does not reach end of pelvic fin in specimens less than 100 mm. Lower lobe of caudal fin shorter than upper lobe in specimens smaller than 200 mm [13] (not evident in figures). At 18–20 mm scalation nearly complete; [3] at 30–35 mm scalation complete and scales on chest smaller than those on sides and abdomen. At 18–20 mm lateral line developed anteriorly, extending to middle of base of soft dorsal fin.[3] At 18–35 mm chin barbel present as minute knob. At 15–100 mm gill rakers on lower limb 3–8 (average 5.8); at 100–150 mm, 3–7 (average 5.5); at 150–200 mm, 0–7 (average 4.8).[13]

Pigmentation: At 10 mm body densely dotted with dark chromatophores; pigmentation in some almost general, dark brown; may be paler if taken on white sand; spinous dorsal, pelvic and pectoral fins colorless; caudal fin colorless or with one or a few dark dots on base; posterior half of base of soft dorsal fin and most of base of anal fin variably black, remainder of these fins colorless. At 13–15 mm body still dark brown; spinous dorsal, pectoral, and pelvic fins remain colorless; amount of black pigment on base of soft dorsal and anal fins varies among specimens from a small spot on base of each fin to a long band or blotch involving a considerable portion of each fin; caudal fin colorless, except for a pair of more or less triangular black spots at base. At 18–20 mm pigmentation variable, depending on environment, some almost uniformly brown, others silvery with scattered brownish chromatophores; spinous dorsal (except for a few black dots), pectoral, and pelvic fins plain translucent; caudal fin void of color except for a pair of dark blotches at base, which may be separate or united; dorsal and anal fins largely black at base in some specimens, with only a few dark points in others. At 30–35 mm ground color silvery, overlaid on sides and back with grayish dots; some with indications of dark blotches present on sides, others uniform silvery gray; dorsal, anal, and caudal fins more or less dotted with black, paired fins usually plain translucent. At 50–60 mm plain silvery gray; dark points still evident on sides and back, but smaller and less numerous.[3] Specimens larger than 50 mm usually lack lateral bars characteristic of *M. saxatilis* and *M. americanus;* a few specimens smaller than 50 mm may have dark bars, dashes, and blotches similar to *M. americanus.*[13]

Distinguished from *M. saxatilis* and *M. americanus* as follows: At 10–15 mm slender body, broad head somewhat quadrate in cross section, small elliptical pupil, broad asymmetrically rounded caudal fins, and absence of black on spinous dorsal and pelvic fins; at 18–20 mm, separable from both by more slender body, and from *americanus*, but not *saxatilis* by strongly elliptical pupil and short asymmetrically rounded caudal fin.[3] At 38–51 mm head and body almost uniform grayish brown, somewhat lighter beneath and finely punctulate with darker; membrane of spinous dorsal with small brown punctulations between second and fifth spines; soft dorsal fin similarly marked along outer margin and along middle third of width; caudal fin punctulate at base and on prolonged lower lobe; other fins hyaline.[2]

GROWTH

Probably similar to *M. americanus;*[1] individuals 9–21 mm in June may attain 129–149 mm by October.[8]

AGE AND SIZE AT MATURITY

Probably mature at about same age as *M. americanus*.[1] Specimens 210 and 310 mm width well developed roe taken in Texas.[4]

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Menticirrhus saxatilis (Bloch and Schneider), Northern kingfish

ADULTS

D. IX or X [13] (usually X [8,9,13,14])–I, 22 [13]–27 [9,13] ($\bar{x}$ 24.5 [13]); A. I [8,9,13] (Miller and Jorgenson, 1973, report II [14]), 7 [13,14]–9 [8,13] (usually 8 [8,9,13]); C. 9+8, procurrent rays 6–8+6; [14] P. 18–21 (usually at least 20 [13]); V. I, 5; [9] vertical scale rows above lateral line 68–101; [13] vertebrae 10+15; [14] gill rakers tuberculate (3–5+0–7 [22]) or absent; [13] branchiostegal 7; [9] teeth in jaws villiform, set in bands, the outer ones in upper jaw slightly enlarged,[8] no molariform teeth on pharyngeal plates.[13]

Head 3.0–4.1, depth 3.6 [8]–4.6 [9] in SL; snout 2.9 [8]–3.7,[9] eye 2.8–4.6, interorbital 3.5–4.4, maxillary 1.3–2.8, pectoral 1.0–1.4 in head.[8]

Body elongate, rounded; back elevated; [8] ventral side

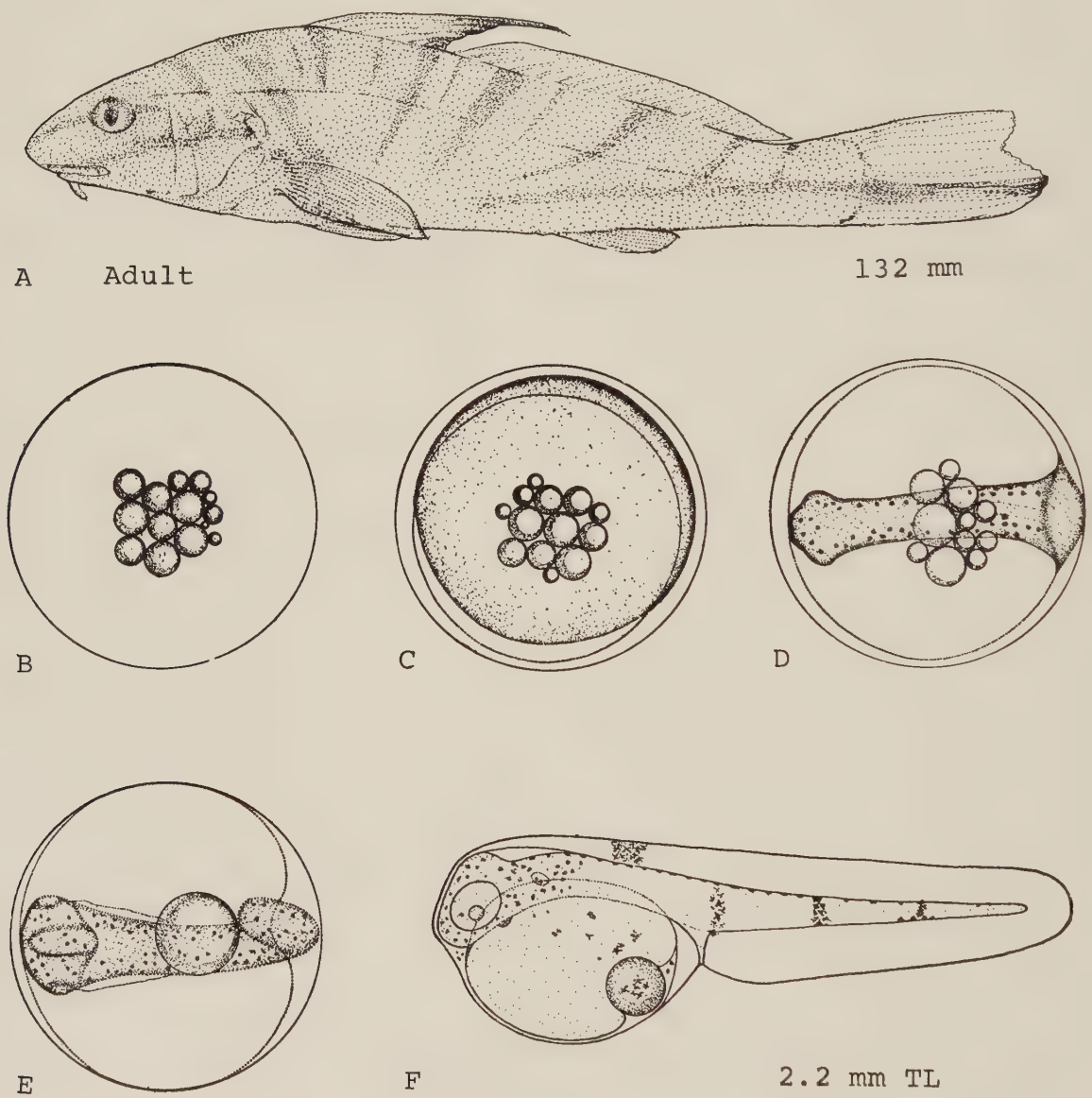

Fig. 130. *Menticirrhus saxatilis,* Northern kingfish. A. Adult, 132 mm (but stage putative, size at maturity unknown), showing basic adult body form and color pattern. B. Egg, newly fertlized. C. Egg, 17.5 hours after fertilization. D. Egg, 24 hours after fertilization. E. Egg, 27.5 hours after fertilization. F. Yolk-sac larva, 2.2 mm TL. (*A, Composite drawing by Joan Ellis based on Ginsburg, I., 1952a: fig. 8 and color notes from LNC. B-E, Welsh, W. W., and C. M. Breder, Jr., 1923: figs. 46–50.*)

ather flat (LNC); head low, snout conical, projecting beond mouth; mouth horizontal, inferior; chin with a ngle short, barbel [8] and perforated by an apical pore nd with 4 lateral pores (LNC); maxillary reaching bew middle of eye.[8] Dorsal fin continuous with a notch etween spinous and soft portions (LNC); dorsal spines ender, flexible, the third produced,[8] when depressed sually reaching past the fourth dorsal soft ray in specimens longer than 200 mm (LNC); soft dorsal fin rather ong and low; caudal fin with concave upper lobe and omewhat produced lower lobe; [8] tip of pectoral fin extending past the tip of pelvic fin in most specimens 150–50 mm and in all those larger than 250 mm.[13] Scales mall, firm, strongly ctenoid,[8] those on breast uniform in ze, about as large as those along lateral line.[13] Preercle serrate.[8]

igmentation: In live specimens upper part of body lvery gray or tan, with dark lateral bars as follows: Jsually a dark streak from middle of upper jaw back oward opercular spines, where it is met by an oblique ar running ventrally and posteriorly from above supraccipital; posterior to head, usually 5 oblique bars; first ar running from nape ventrally and posteriorly towards rea just behind pectoral axil; second bar running from osterior part of base of spinous dorsal fin anteroventrally o same area as first to form a "V" shaped marking (secnd bar often broadest and most distinct as in *M. amerianus*); a patch of pigment at origin of spinous dorsal, nlike *M. americanus;* 3 bars running ventrally and aneriorly from base of second dorsal fin, but not parallel s in *M. americanus;* backwards slant of bars increases rogressively from second to fifth bar. As in *M. amerianus* a dash is present on upper part of caudal peduncle nd blotches are present below lateral line; in larger pecimens, blotches merge to form a black horizontal ripe which continues anteriorly onto lower lobe of audal fin (lacking in adult *M. americanus*); distal porion of spinous dorsal usually dusky or black; pectoral, elvic, and anal fins dark in most specimens larger than 00 mm; upper half of inner side of opercle dark or lack, lower part lighter (dark all over in *M. mericanus*).[13]

Distinguished from other species of *Menticirrhus* by the ark "V" on anterior part of side, the produced third orsal spine,[8] and having typically 8 anal spines.[10]

Maximum size: Largest recorded 550 mm TL, 1.5 kg.[2]

ISTRIBUTION AND ECOLOGY

ange: Western Atlantic from Maine to Progresso, Yucan; common between Cape Cod and North Carolina; elatively few adults taken from South Carolina to Texas, ut juveniles appear on beaches regularly each year.[13]

rea distribution: Chesapeake Bay in Calvert, Somerset, nd St. Mary's counties, Maryland [11] and Cape Charles, Buckroe Beach, Ocean View, Lynnhaven Roads, Gunston Wharf, and lower York River, Virginia; [8] Worcester County, Maryland; [11] ocean coast of Virginia; [16] Delaware Bay; [7] Atlantic, Cape May, and Ocean counties, New Jersey.[10]

Habitat and movements: Adults—frequent sandy bottoms just outside surf and sandy channels in vicinity of inlets; [4] move to deeper waters with growth; commonly taken from 7–45 m, deepest record 126 m.[13] Taken May–October in Gulf of Maine,[12] April–October in New York area,[2] May–October on Virginia's eastern shore,[16] September–October off Ocean City, Maryland.[17] Taken at temperatures from 7.8–35.8 C; [13] in South Carolina taken only during warmer months when temperatures above 20 C.[1]

Larvae—specimens 2.6–6.0 mm taken June–August in Narragansett Bay at 21.1–23.2 C; [18] 14 specimens 1.9–4.5 mm taken on beaches at Long Island late June–July.[5]

Juveniles—apparently live on or near bottom like adults; specimens less than 70 mm taken in surf on outer shores of banks at Beaufort; [6] in northern Gulf of Mexico specimens less than 60 mm taken in open surf of outer sandy beaches during summer.[13] In Delaware River estuary taken mainly in late summer to late October; [7] taken summer and fall in Chesapeake Bay,[8] July–September off Virginia,[16] every month except May and September in Tampa Bay area.[21] In Delaware River estuary taken in salinities as low as 5 ppt,[19] common only above 16 ppt; [7] in York River, Virginia taken only from upper reaches of river in salinities usually less than 5 ppt (LNC); taken in salinities as high as 35.1 ppt in Tampa Bay area. Taken at temperatures from 13.5–30.7 C.[21]

SPAWNING

Location: Apparently spawn in outside waters,[7,19] the young probably being transported passively into bays.[7]

Season: Occurs June–August in Gulf of Maine; [12] reaches maximum in June in New York, continuing into September; [2] June–August in New Jersey, with a maximum in late June or early July; [4] April–May or possibly longer in North Carolina [6] and South Carolina.[1]

EGGS

Buoyant; spherical; almost colorless, with a faint yellowish tinge; average diameter 0.8–0.85 mm; one to as many as 18 oil globules, coalescing to one by hatching; diameter of oil globule 0.19–0.26 mm when only one, 0.02–0.14 when many.[4]

EGG DEVELOPMENT

Segmentation and development as in *Bairdiella chrysoura.* About 18 hours after fertilization grayish

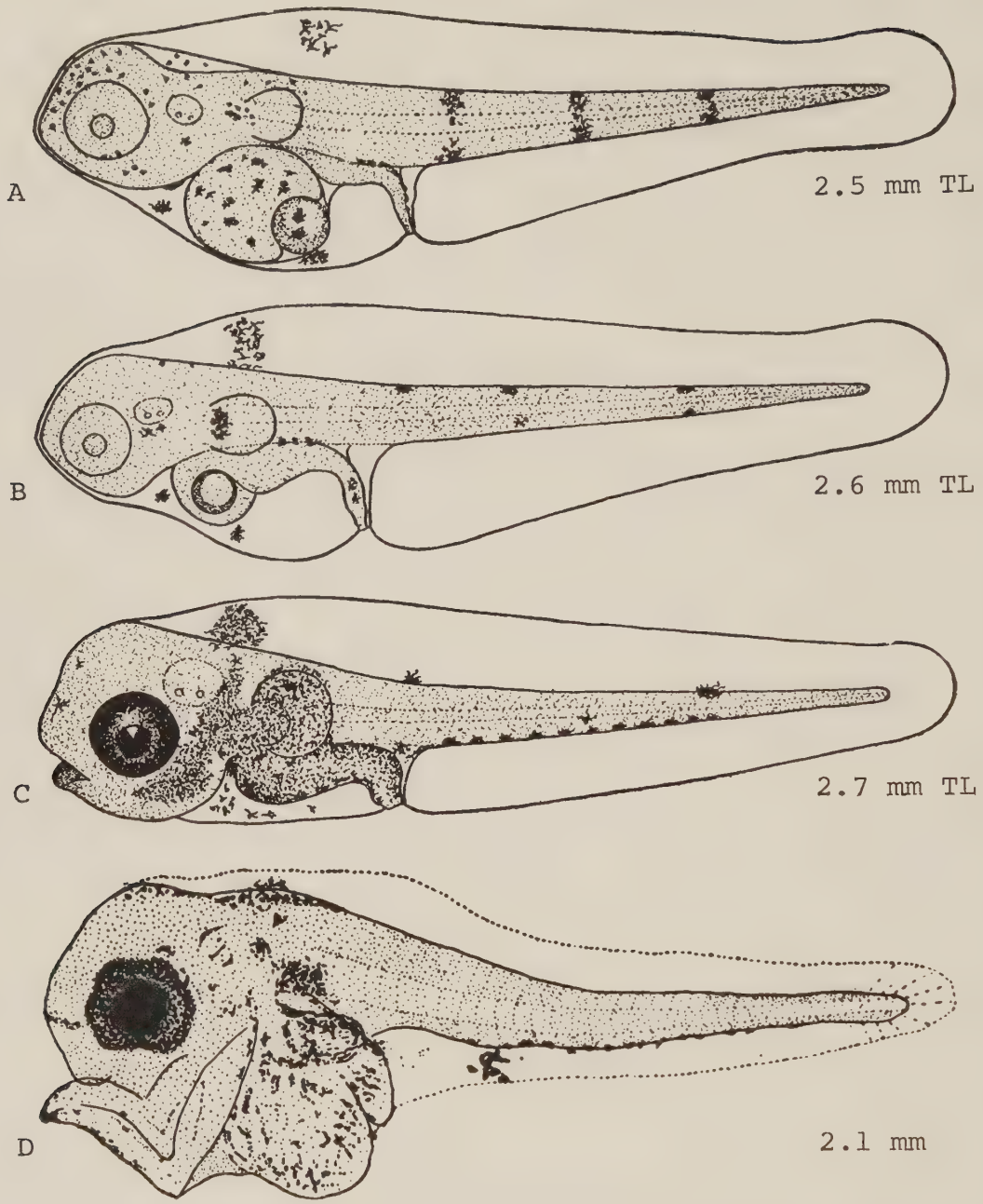

Fig. 131. *Menticirrhus saxatilis,* Northern kingfish. A. Yolk-sac larva, 2.5 mm TL. B. Yolk-sac larva, 2.6 mm TL. C. Larva, 2.7 mm TL. D. Larva, 2.1 mm. *(A-C, Welsh, W. W., and C. M. Breder, Jr., 1923: figs. 51–53. D, Perlmutter, A., 1939: fig. 7A.)*

chromatophores distributed over dorsolateral aspects of embryo and on surface of oil globule. At 24 hours chromatophores on oil globule black and stellate and embryo dotted with black punctulations; a number of small black chromatophores scattered over dorsal surface of yolk sac.[4]

Hatch in 46–50 hours at 20–21 C.[4]

YOLK-SAC LARVAE

Hatch at about 2–2.5 mm.

Oil globule located in posterior part of yolk sac. Pectoral fin faintly visible on second day. Mouth open and functioning on fourth day.[4]

igmentation: At hatching pigmentation consists of 3 ertical bands of black and dull gold chromatophores, ne above the anus and 2 posterior to it, dividing the audal region into 3 nearly equal parts; a patch of black nd dull gold pigment in dorsal finfold anteriorly and milar chromatophores scattered over yolk sac. On third ay after hatching vertical bands, especially anterior nes, becoming faint. On fourth day only traces of audal bands visible; a row of black chromatophores resent on ventral surface posterior to vent, extending o location of middle band; blotch in dorsal finfold still onspicuous; eye pigmented; pectoral fin with black and old chromatophores; abdomen with golden tinge.[4]

ARVAE

tage completed by 5.0 mm.[3]

y 4.5 mm caudal and anal fin rays differentiating;[20] t 5.0 mm almost all soft dorsal and anal fin rays deeloped.[3]

ossibly differentiated from *M. americanus* at 3–5 mm L by presence of more pigment laterally on visceral nass in *M. saxatilis* (HWP).

igmentation: At 3.7 mm melanophores present along entral surface of abdomen, few at nape, and in rows nidlaterally and midventrally; pigmentation on upper lip nd patch on roof of mouth which is visible externally.[20]

UVENILES

escribed from specimens 10 mm and larger.

t 10 mm all fins with full complement of rays. At 10 nm body rather deep, compressed, depth 2.8–2.9 in SL; ead narrow, compressed, about equal to depth; eye nger than snout, pupil vertically elongate; mouth large nd moderately oblique; upper jaw projecting beyond wer. At 18–20 mm body more slender, still strongly ompressed, depth 3.2–3.4 in SL; head broader; mouth ightly oblique and nearly terminal; snout scarcely proecting beyond upper jaw. At 30–35 mm body more longate and less strongly compressed, depth 3.5–3.6 in L; mouth horizontal and inferior, snout projecting noderately beyond it. At 50–60 mm depth 3.8–4.1 in L; snout conical, projecting much more strongly, somehat longer than eye.[6] In specimens less than 100 mm epressed spinous dorsal fin usually reaches past base of rst soft ray; at 50–100 mm reaches past fourth soft ray; t 100–200 mm, reaches past fifth soft ray.[13] At 10 mm audal fin asymmetrically rounded, longest rays in lower obe; at 18–20 mm broadly pointed; at 30–35 mm slightly ngular; at 50–60 mm margin slightly concave. At 10 mm ectoral and pelvic fins coterminal, not reaching anus;[6] ectoral fin does not extend past pelvic in specimens less han 100 mm.[13] At 18–20 mm scalation nearly complete and lateral line developed anteriorly to about middle of base of soft dorsal fin; scalation complete by 30–35 mm. At 18–20 mm mandibular barbel evident as a slight knob at symphysis of lower jaw; at 30–35 mm barbel short, but plainly evident. At 14–50 mm gill rakers on lower limb of first arch 0–8 (average 4.8); at 50–100 mm, 0–7 (average 2.9).[6]

Pigmentation: At 10 mm (specimens described taken in black vegetable debris) body almost everywhere dotted with prominent black chromatophores; indefinite brownish band present on back below base of dorsal fin and another extending along ventrolateral edge from origin of anal fin to base of lower caudal rays; spinous dorsal fin almost wholly black; soft dorsal fin colorless, except for an indefinite elongate dark band on base of about middle third of fin; caudal fin colorless, with a white base and sometimes with one or a few large black chromatophores; anal fin colorless, except for dark dots on base; pelvic fin wholly black and pectoral fin plain translucent. At 18–20 mm general color (of specimens taken in black vegetable debris) almost uniform dark brown, with slight indication of a broad vertical bar, darker than ground color, on side under spinous dorsal, and another under middle of base of soft dorsal; spinous dorsal and pelvic fins black; pectoral fin colorless; soft dorsal and anal fins with at least a partly black base, remainder colorless; caudal fin colorless, except for a black blotch on base. At 30–35 mm body pigment ranging from adult color pattern to almost uniform blackish brown;[4] ground color silvery, brightest on lower parts of body, overlaid almost everywhere with dark brown dots. Dark bars evident in majority of specimens, the first running from posterior part of head obliquely downward and backward on opercle, the second crossing the nape parallel to the first, the third under the spinous dorsal bending forward to join or nearly join the second on middle of side; the second and third bars together form the "V" which is a diagnostic adult feature; dark blotches suggestive of bars present posterior to the 3 described; spinous dorsal and pelvic fins remain almost wholly black; soft dorsal and anal fins black at base or at least dotted with black; caudal fin with 2 irregular dark spots on base, otherwise plain translucent; pectoral fin plain, more or less dotted with black at base. At 50–60 mm color quite variable; some dark brown, others silvery gray; all with rather definite oblique dark bars on anterior part of body and a few blotches posteriorly; spinous dorsal and pelvic fins remain almost wholly black in darker specimens, only partly dusky in lighter ones.[6]

At 10 mm characterized by deep, strongly compressed body; narrow, compressed head; small elliptical pupil; broad, asymmetrically rounded caudal; and black spinous dorsal and pelvic fins. At 18–20 mm body deeper than *M. americanus* and *saxatilis;* distinguished from *M. americanus* by elliptical pupil and bluntly pointed tail which is shorter than head; distinguished from *M.*

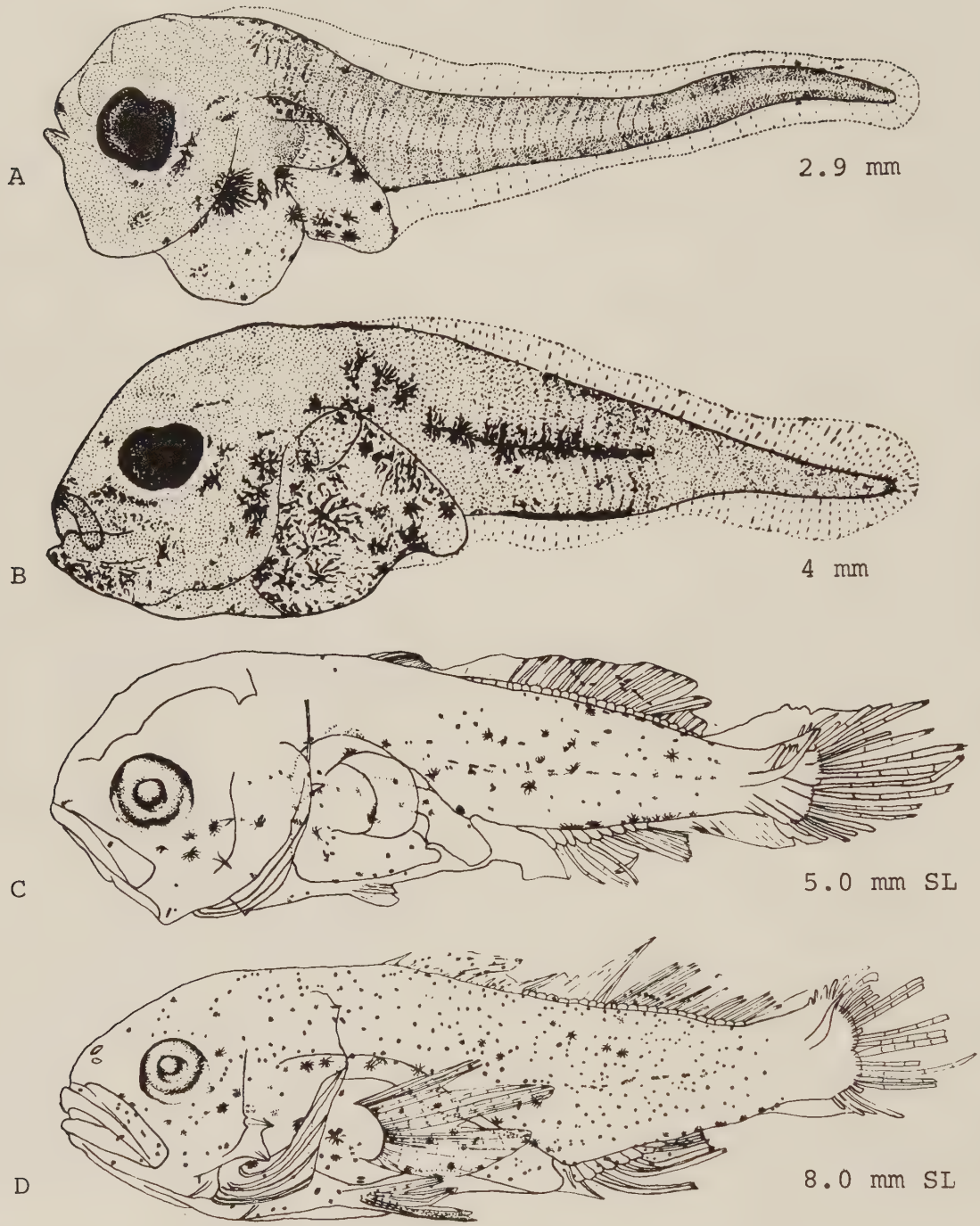

Fig. 132. *Menticirrhus saxatilis*, Northern kingfish. A. Yolk-sac larva, 2.9 mm. B. Larva, 4 mm. C. Larva, 5.0 mm SL. D. Larva, 8.0 mm SL. (*A, B, Perlmutter, A., 1939: figs. 7B-C. C, D, Jannke, T. E., 1971: fig. 22.*)

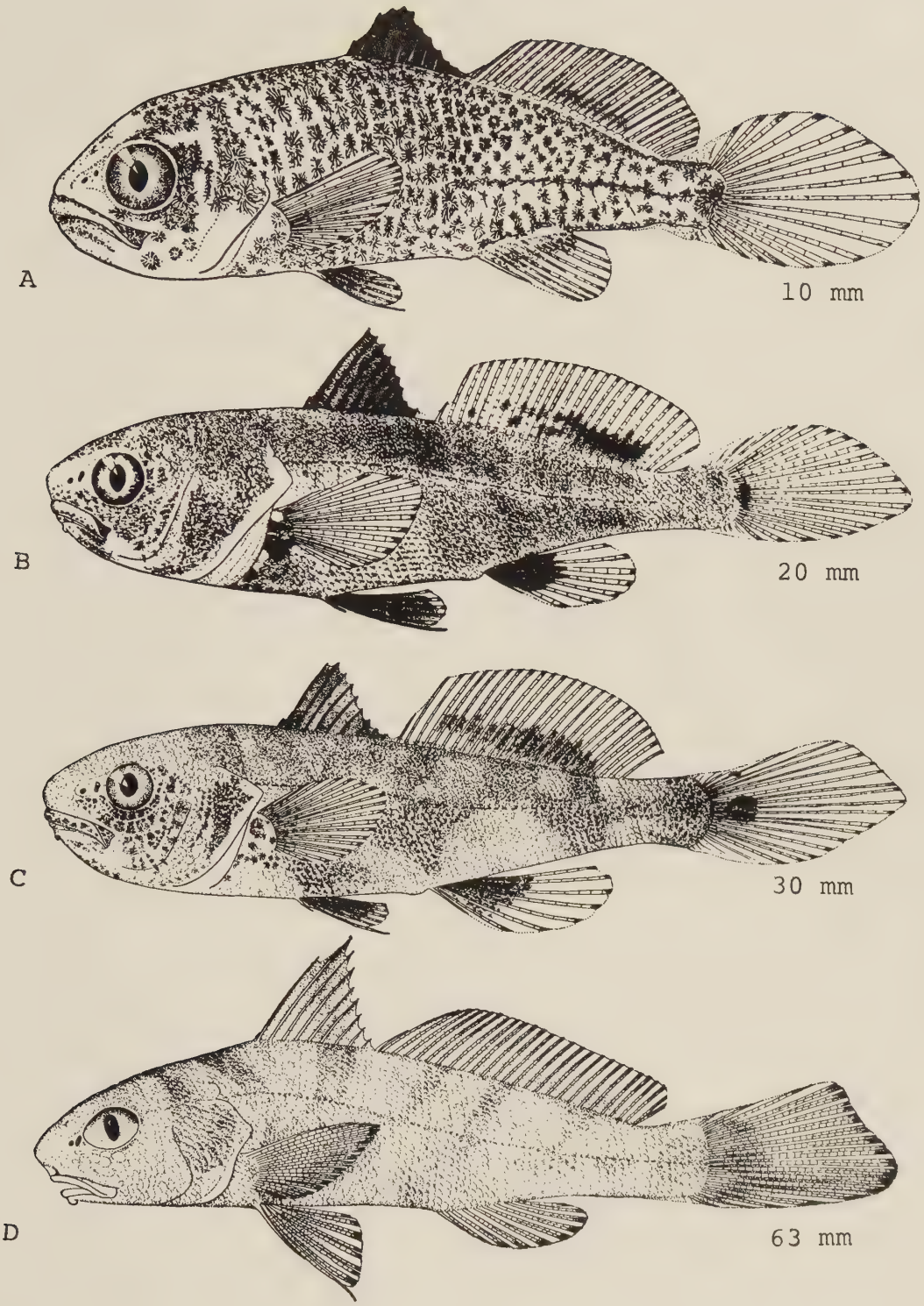

Fig. 133. *Menticirrhus saxatilis*, Northern kingfish. A. Juvenile, 10 mm. B. Juvenile, 20 mm. C. Juvenile, 30 mm. D. Juvenile, 63 mm. (*A-D, Hildebrand, S. F., and L. E. Cable, 1934: figs. 11–14.*)

littoralis by dark cross bars on body, black spinous dorsal and pelvic fins. At 30–35 mm still deeper than both other species; differs from *americanus* in elliptical pupil and short angulate caudal fin; differs from *littoralis* in presence of large scales of uniform size on chest. By 50–60 mm recognizable by same characters as adult: small scales of uniform size on chest, rather high spinous dorsal (the third ray becoming conspicuously reduced) with longest spines reaching well beyond origin of soft dorsal, anal fin typically with 8 soft rays; pectoral fin usually reaching to tips of pelvic, rather definite black bars on back and sides, 2 of which form a definite "V" above pectoral fin, and the small vertically elongate, elliptical pupil.[6]

GROWTH

Growth during first year as indicated by seining captures in New York bay areas: 25–125 mm (average 76 mm) in July; 25–225 mm (average 141 mm) in August; 45–265 mm (average 166 mm) in September; 25–315 mm (average 202 mm) in October. Average yearly lengths of New York specimens based on scale analysis: I, males 256.3 mm TL, females 265.5 mm TL; II, males 322.0 mm TL, females 343.1 mm TL; III, males 354.6 mm TL, females 387.6 mm TL; IV, males 370.7 mm TL, females 413.1 mm TL; maximum average expected sizes based on growth curves 386.6 mm TL for males, 447.5 mm TL for females.[2] Modal lengths in New Jersey based on scale analysis: 120 mm first winter, 250 mm second winter, 350 mm third winter. At Woods Hole fish hatched early in June may reach 20 mm by July 1, 80 mm by August 1, and over 150 mm by September 1.[4]

AGE AND SIZE AT MATURITY

Males probably mature at 2 years, females at 3 years; [4,12] more than 50% of all 1–2 year old males in New York running ripe, while a large percentage of females of same age group at or approaching spawning condition, all young of the year immature.[2]

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*Micropogonias** *undulatus* (Linnaeus), Atlantic croaker

ADULTS

D. X–I,[19,24] 26–30 (usually 28 [1]); A. II, 7 [21]–9 [34] (usually 8 [1,19,24]); C. 9+8, procurrent rays 8–9+8; [24] P. 17–20 (usually 18 [1]); V. I, 5; [21] lateral line scales 47–50 (usually 50), scales above lateral line 7–9 (usually 8), scales below lateral line 8–9 (usually 8 [1]); vertebrae 10+15; [24] gill rakers 8–10+14–18; [34] branchiostegals 7; [21] teeth small, conical, set in bands, in broad villiform bands, outer row teeth in upper jaw and inner row teeth in lower jaw enlarged (LNC); no teeth on vomer, palatines, or tongue.[21]

Head 2.9–3.4, depth 2.9–3.6 in SL; snout 2.8–3.7, eye 3.3–4.8, interorbital 3.3–3.8, maxillary 2.3–2.8, pectoral fin 1.1–1.5 in head.[19]

Body elongate, moderately compressed; back slightly elevated; head rather long; snout conical, projecting beyond mouth; mouth moderate, horizontal, inferior; maxillary reaching a little past front margin of eye to below middle of eye; chin with five pores and 3 pairs of short, slender barbels. Scales moderate, strongly ctenoid, reduced anteriorly above lateral line, extending onto caudal, but not on other fins.[19] Dorsal fin continuous with a deep notch between the spinous and soft portions (LNC); third and fourth dorsal spines longest, higher than any of soft rays; caudal fin slightly double concave, the middle rays longest; pectoral fin reaching well beyond tip of pelvic fin. Preopercular margin with strong spines.[19]

Pigmentation: Greenish or grayish silvery above, silvery white below, highly iridescent in life; back and sides with numerous brassy or brownish dark spots arranged in oblique, wavy bars on sides, becoming less distinct in large individuals; dorsal fin with numerous dark spots; [19] faint longitudinal streaks usually present on soft portion of dorsal fin (LNC); caudal and pectoral fins greenish dusky; base of pectoral fin dusky; anal and pelvic fins yellowish to orange.[19] Spawning coloration distinctly bronze or yellow; iris golden on dorsal margin; pelvic fin yellow; pectoral fin blackish at base; inside of mouth pinkish red; anal fin bronze yellow; caudal fin faint yellow; preopercle bronze.[1] (This coloration characterizes all large specimens and may not be associated with spawning, LNC.)

Readily recognized by inferior mouth, series of short barbels on each side of chin, and strongly serrated preopercular margin.[19]

Maximum size: Largest recorded 668 mm from northern Gulf of Mexico.[16] South of Cape Hatteras, typically small, mostly 200 mm or less, maximum 300–350 mm; [3,6,9,13,14,31] north of Cape Hatteras, larger average size [13] (258 mm [11]), and maximum size about 500 mm or more.[13]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Cape Cod, Massachusetts [2,13] to Campeche Bank, Mexico,[13] not common north of New Jersey; [2,19] probably occurs in southern Florida only as a result of occasional southward migrations due to unusually cold winter conditions.[1]

Area distribution: Chesapeake Bay, widespread in Virginia and Maryland [18] south of Baltimore; [19] Worcester County, Maryland; [18] eastern shore of Virginia; [23] Delaware; [25,27] Atlantic, Cape May, Burlington, Cumberland, Monmouth, and Ocean counties, New Jersey.[33]

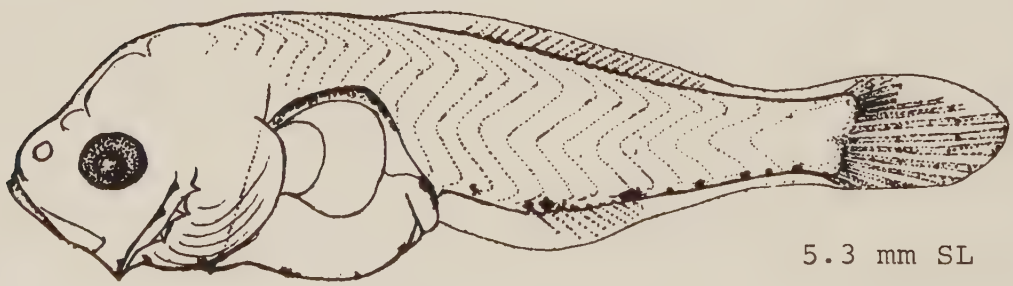
Habitat and movements: Adults—found on mud, sand, mud-sand mixtures, mud and shell, and on "live" bottoms of sponge and coral; most abundant on bottoms of mud and sand mixture, particularly near mouths of tidal sounds and several miles offshore in depths of about 5.9 m [6] to as deep as 54 m (LNC). In Chesapeake Bay and North Carolina move up bays and estuaries during spring, randomly in summer, and oceanward in fall; distance traveled maximum during spring and fall, minimum in August; specimens tagged off Maryland–Virginia coast in fall migrate to waters off North Carolina coast; none tagged in North Carolina recovered in Chesapeake Bay area.[11] Taken in Chesapeake Bay March–October, and a few as late as early December, bulk March, April, and May; [19] sexually mature individuals leave as early as July, but mainly during August, and all have left by September 15.[12] In Gulf of Mexico migrate offshore to spawn in fall; [3,4,22,30,31] most abundant April–May, steadily decreasing through summer, mostly offshore by early winter.[26] Off Mississippi most abundant offshore in September and May; at 9 m, most abundant fall and summer; at 18–36 m, most abundant fall and winter; at about 54 m most abundant spring and summer.[30] Water temperature apparently has direct effect on migration of croakers, particularly in spring and fall; in South Carolina, although most of population is gradually leaving inshore waters by late summer, a mass exodus of remaining fish occurs when water temperatures begin to fall and by November all adults and older juveniles have left coastal waters, the young of previous year (120–200 mm) re-entering sounds and rivers in early spring when temperature reaches about 16 C; exodus from Lake Pontchartrain, Louisiana, September–November also directly correlated with drop in water temperatures.[7] Taken in salinities from 0 [5,6]–40 ppt [30] (70 ppt in Laguna Madre, Texas [10]), more abundant at higher salinities.

*The name *Micropogon* is preoccupied by a bird genus, Bore 1827. The correct substitute name is *Micropogonias* Bonaparte 1831.[34]

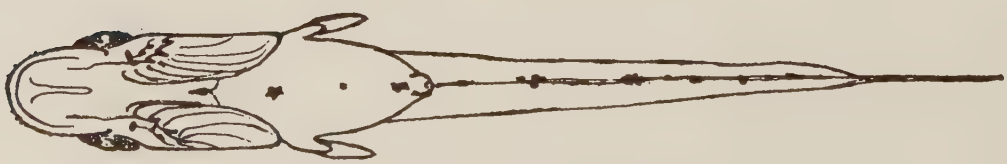
A Adult ca. 245 mm

B 2.5 mm

C 4.0 mm



D 5.3 mm SL



E

Taken at temperatures from 6.7–35.5 C; [5] in Louisiana and Texas specimens 1 year or older absent at temperatures below 10 C.[9]

Larvae—spend first days at sea, entering inside waters at about 8–15 mm; [6] minimum size in Beaufort, N.C. harbour 3.5 mm; [3] common along banks of North Carolina during winter and may be taken as far as 19–24 km offshore.[3] Taken in Chesapeake Bay during winter; [12] taken September–May at Beaufort; [3] taken October–May in South Carolina; [6] taken October–February at Port Aransas, Texas.[4] Larvae and juveniles taken at salinities from 0–21 ppt and temperatures from 0–24 C in upper Chesapeake Bay.[20]

Juveniles—found in estuarine and coastal waters at moderate depths to shoal waters.[5,9,15] In South Carolina most taken in tidal streams of marshland over bottom of soft mud and plant detritus; most move well up into tidal streams to areas of reduced salinity, and then seaward as growth proceeds; few remain in tidal rivers or sounds more than 1 year.[6] In Gulf of Mexico, use bays as nursery areas, and generally migrate back to Gulf by July before reaching 80–90 mm.[9] First taken inside Mobile Bay in October, widespread by November; [5] larger specimens leave in July and August, return in fall, also may move offshore for brief periods in winter.[5] Taken in Texas and Louisiana bays, October–April; [22,26] at Port Aransas most abundant in February, none less than 53 mm taken May and afterwards.[22] Taken on eastern shore of Virginia, September–November.[23] Taken in Chesapeake Bay during spring and summer, mostly concentrated midway up estuary at about 18 ppt salinity, primarily confined to bottom waters of relatively deep channels.[15] Show apparent cline of increasing size to increasing salinity, perhaps due to upstream bottom currents of high salinity carrying small individuals, whereas larger are more able to actively swim against it; [5,6,15] taken in salinities from 0 [32]–36.7 ppt, most abundant in Texas below 15 ppt.[22] Apparently more cold tolerant than adults,[3,5] remaining in upper reaches of tidal estuaries throughout winter, after most of older fish have moved offshore; [6] taken at temperatures from 5 [25]–32 C; [22] in Louisiana and Texas well adapted to temperatures in 6–20 C range; [9] no significant short term relationship between depth and temperature and size.[5] Specimens less than 50 mm cease feeding at less than 5 C, show loss of equilibrium at 1.5 C, die at 0.5–1.0 C.[29]

SPAWNING

Location: Occurs offshore,[3,4,5,6,12,15,17] probably over a wide area, extending a considerable distance offshore and not just around passes, but some spawning possibly occurs inside deep passes where conditions are favorable; [5] some unconfirmed reports of spawning in larger estuaries such as Delaware and Chesapeake Bays; [2] occurs off Beaufort probably not more than 48 km from outer banks; [3] in South Carolina fish in spawning condition taken from several km offshore in 7.5 m to 80–96 km offshore in depths up to 81 m.[6]

Season: South of Cape Hatteras generally occurs September–March,[3,4,5,9,13,14] sometimes extending as late as May [3] or June,[9] with a peak around October [13] or November.[4] North of Cape Hatteras generally occurs August–December,[2,12,13,19,28] with a peak in August or September; [13] in Virginia may occur to some extent in almost all months with possibly a spring and fall peak; [15] in Delaware probably occurs from late August to early October.[25]

Fecundity: A 395 mm female had ca. 180,000 eggs; all eggs in ovary of uniform size.[19]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

Specimens described 2.8–10 mm.

At 2.8 mm no indication of fin rays in finfold; at 4 mm some thickening at base of soft dorsal and anal fins; at 6 mm soft dorsal fin fairly well developed, anal fin with full complement of spines and rays; at 10 mm soft dorsal fin fully formed, spinous dorsal only partly developed. At 3.6 mm notochord beginning to flex, rudiments of fin rays evident; at 4 mm notochord completely flexed and caudal fin well formed; at 10 mm caudal fin quite long, its posterior margin strongly convex. At 6 mm pectoral fin evident, pelvic fin not evident; at 10 mm pectoral fin with some rays present, pelvic fin visible as membranous tuft. At 2.8 mm body rather deep, dorsal outline quite regular and rather evenly convex; mouth large and nearly vertical. At 2.8 mm hind gut projecting rather prominently, but not wholly free distally; at 3.6 mm hind gut apparently connected with body by semitransparent membrane; at 4 mm still prominent, distance between anus and anal fin origin about same as diameter of eye (HWP).

Fig. 134. *Micropogonias undulatus*, Atlantic croaker. A. Adult, ca. 245 mm SL. B. Larva, 2.5 mm. C. Larva, 4.0 mm. D. Larva, 5.3 mm SL. E. Ventral view of D. (*A, Goode, G. B., 1884: pl. 128. B, C, Hildebrand, S. F., and L. E. Cable, 1930: figs. 51–52. D, E, Lippson, A. J., and R. L. Moran, 1974: 229.*)

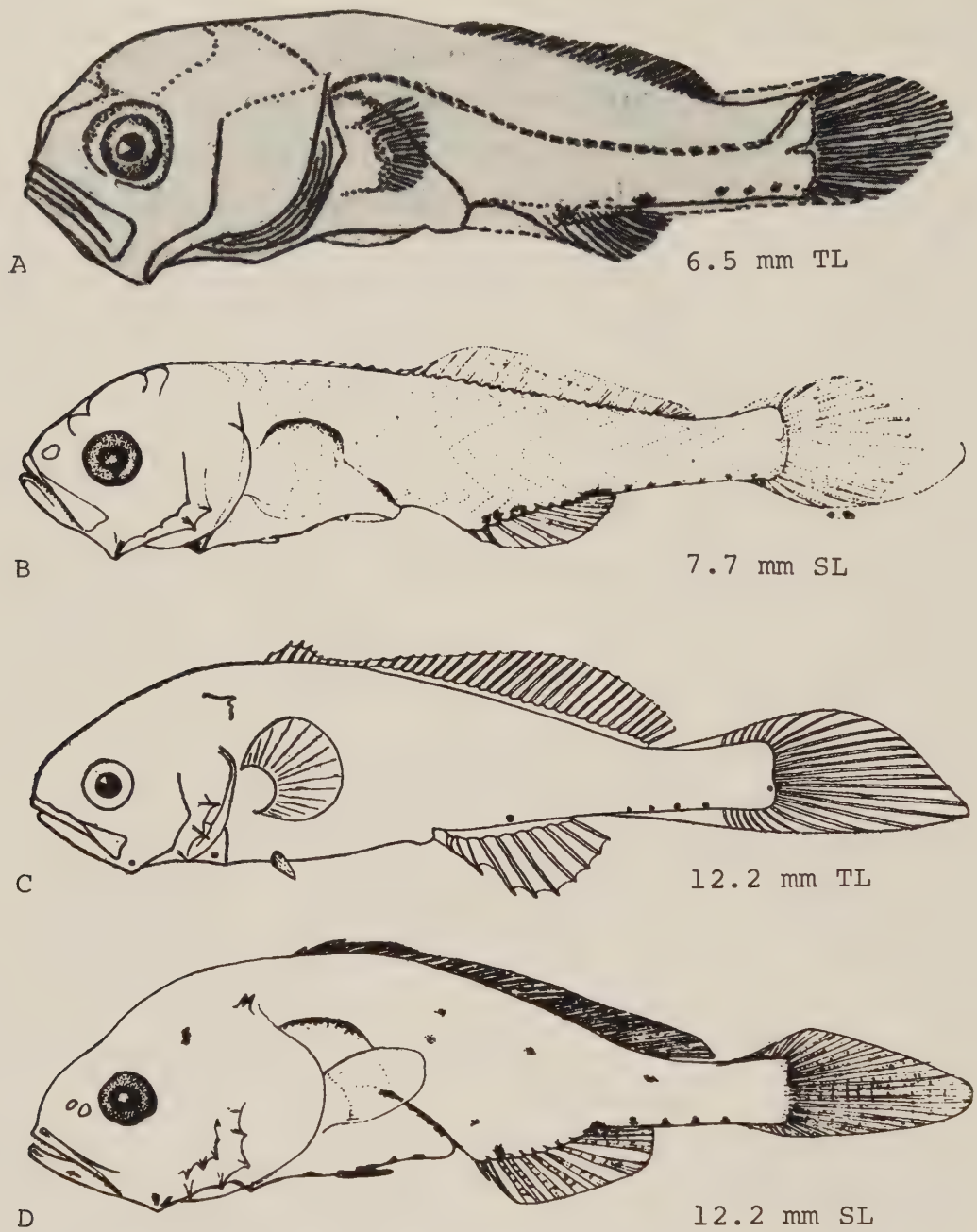


Fig. 135. *Micropogonias undulatus,* Atlantic croaker. A. Larva, 6.5 mm TL. B. Larva, 7.7 mm SL. C. Larva, 12.2 mm TL. D. Larva, 12.2 mm SL. (*A, Pearson, J. C., 1929: fig. 33. B, D, Lippson, A. J., and R. L. Moran, 1974: 229–230. C, Welsh, W. W., and C M. Breder, Jr., 1923: fig. 39.*)

Pigmentation: At 2.8 mm a dark, crescent-shaped area present above visceral mass where dark peritoneum visible through body wall; a row of dark points present along ventral edge of caudal portion of body; an indistinct dark spot at mandibular symphysis. At 4 mm pigmentation about same except for a few black chromatophores around hind gut.[3] At ca. 4.9 mm SL, ventral surface of visceral mass with a melanophore just posterior to cleithral symphysis, one just anterior to anus, and one midway between these (HWP). At 6 mm 2 very small chromatophores at base of anal, one generally between first and second soft ray, the other directly posterior to last ray; 3–5 small chromatophores lie posterior to anal fin along ventral edge of caudal peduncle;

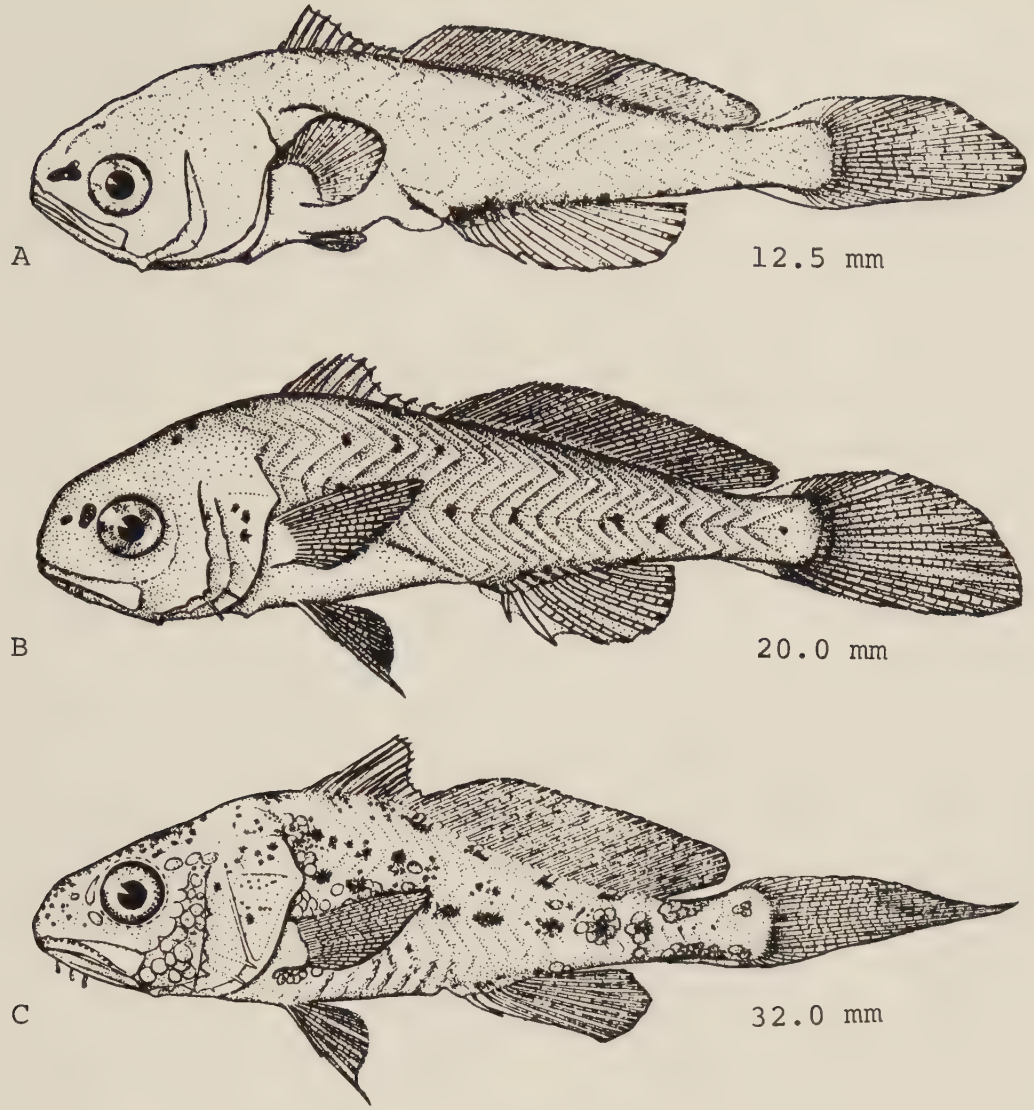


Fig. 136. *Micropogonias undulatus*, Atlantic croaker. A. Larva, 12.5 mm. B. Juvenile, 20.0 mm. C. Juvenile, 32.0 mm. (*Hildebrand, S. F., and L. E. Cable, 1930: figs. 53–56.*)

no dorsal chromatophores evident.[4]

At 5 mm separable from *Pogonias cromis* and *Sciaenops ocellata* by somewhat deeper body, slightly larger eye, and particularly, the absence of dark markings along back; also separable from these species at about 3 mm by the presence of 3–7 dark chromatophores along ventral edge of tail.[3] Separable from *Leiostomus xanthurus* by absence of pigment on anterior surface of visceral mass between cleithra; by presence of three melanophores in line in ventral midline between cleithral symphysis and anus (not always reliable);[35] especially by pigment along anal fin base having a break above mid-anal base (spot only at anterior and posterior ends) in *Micropogonias undulatus* versus a continuous row of pigment in *Leiostomus xanthurus* (BWS).

JUVENILES

Specimens described 11–110 mm.

Dorsal and anal fins with full complement of spines and soft rays by 11[3]–15 mm. At 11 mm middle rays of caudal fin considerably produced;[4] at 30 mm middle rays of caudal fin still much produced, being nearly equal to length of head;[2,3] at 65 mm caudal fin still pointed, but becoming proportionately shorter; at 110 mm margin of caudal fin approaching slightly double concave shape of adult, with the upper and middle rays the longest.[3] At 11 mm pelvic and pectoral fins distinct;[4] at 15 mm pectoral and pelvic fins larger and with definite rays;[3] at 30 mm first ray of pelvic fin reaching to or beyond anus. At 21 mm body slender; depth 3.4 in SL;

mouth oblique and terminal. At 30 mm head about 3 in SL, eye 3–3.5 in head; [2] mouth almost horizontal. At 50 mm many adult characters present, but still quite different in general appearance; snout not yet projecting beyond upper jaw; mouth still a little oblique. At 65 mm back less prominently developed than in adult and ventral outline scarcely as straight; snout projecting slightly beyond upper jaw, lower jaw definitely included; mouth horizontal. At 110 mm shape essentially that of adult; back prominently elevated, ventral outline straight from chin to anus; snout projecting prominently beyond inferior, horizontal mouth.[3] Prominent serrations present on opercle and preopercle by 11 [4]–15 mm; by 30 mm serrations very large and sharp; by 110 mm serrations less prominent, but still larger than in adult. At 30 mm mandibular barbels evident in some; by 50 mm generally evident in all.[3]

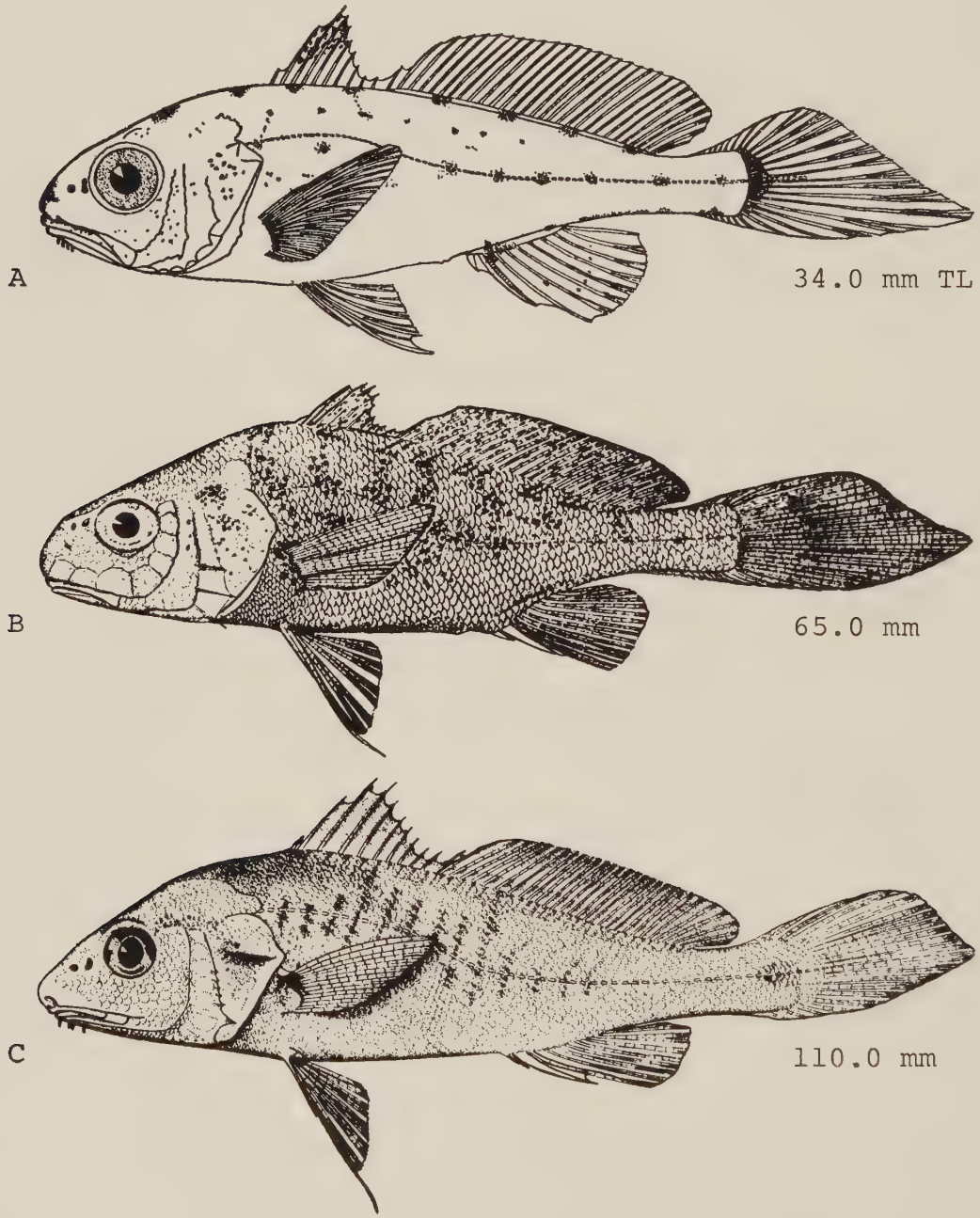


Fig. 137. *Micropogonias undulatus,* Atlantic croaker. A. Juvenile, 34.0 mm TL. B. Juvenile, 65.0 mm. C. Juvenile, 110.0 mm. (*A, Welsh, W. W., and C. M. Breder, Jr., 1923: fig. 40. B, C, Hildebrand, S. F., and L. E. Cable, 1930: figs. 57–58.*)

May be unscaled to 15.0 mm SL; scales first appear along lateral line of caudal peduncle from 14.1–16.0 mm SL; lower half of caudal peduncle covered from 14.1–22.3 mm SL; at 15.3–17.8 mm SL scalation proceeds anteriorly along lateral line and encloses area forward of caudal fin between insertions of soft dorsal and anal fins; at 17.3–20.9 mm SL lateral line scales continue to develop forward to a point nearly even with origin of spinous dorsal with very little increase in body scalation forward of dorsal and anal insertions; at 18.5–20.8 mm SL lateral line scales reach gill opening, body covered to a level midway on spinous dorsal and just forward of anus; at 18.7–23.7 mm SL scalation progresses ventrally at gill opening from lateral line toward belly and scales appear for first time on breast; at 22.0–24.3 mm SL body scalation progresses from lateral line anteroventrally halfway to breast and anterodorsally to origin of dorsal fin as scales first appear on cheek beneath eye and on interorbital area; at 25.3–31.0 mm scales appear in patches around eye, on opercle and preopercle, and in region of nape, while breast becomes nearly covered; at 31.7–37.9 mm head, nape, and breast become completely scaled and scalation is completed; during last half of scalation process, lateral line progresses posteriorly beyond midpoint of caudal fin.[8]

Pigmentation: At 15 mm blackish spot at mandibular symphysis still present; a row of 4 black chromatophores present on median line between isthmus and anus; a prominent black chromatophore lies at base of first soft ray of anal fin [3] and another at termination of anal fin base (BWS); row of 5 chromatophores present on ventral median line between end of anal and base of caudal; about 3 black chromatophores present on base of caudal fin; rest of body unpigmented.[3] At 21 mm pigmentation still not general; an additional row of 6 dark chromatophores extending from nape to end of dorsal fin base and another row of about 4 dark spots along middle of side, between point of pectoral fin and base of caudal fin.[3] At 30 mm pale throughout, punctuated with groups of brownish chromatophores in regular rows, 8 on dorsal line from head to base of caudal, 8–10 on a line from opercular flap to caudal, a less distinct row lying between these; snout, premaxillary, tip of spinous dorsal, base of anal, and base of caudal rays punctulate with brownish spots.[2,4] At 50 mm 3 rows of dark spots, one along edge of back, forming saddle-like blotches in joining those of other side, another along middle of side, and a third row between the 2 others. At 65 mm pigmentation general; sides largely silvery, shading into a silvery gray and green toward the back and pale silvery underneath; a more or less definite dark blotch evident on opercle; other dark markings larger and nearing connection to form the wavy bars characteristic of adult; at 110 mm characteristic coloration of adult present, including oblique wavy bars (dark in preserved specimens, brassy to brownish in life) on sides, dark blotch on opercle and another at base of dorsal.[3]

GROWTH

In Texas bays, first appear in November; 10–50 mm in January; 30–85 mm in March; 40–100 mm in May; 70–130 mm in June; 110–170 mm in August; 120–175 mm in September; 140–180 mm in October; 130–190 mm in November of second year; 165–220 mm in March of second year; 190–270 mm in June of second year; 200–310 mm in September of second year; growth rate apparently similar throughout range.[13] In Lake Pontchartrain, Louisiana reach 90–200 mm in first year.[7] In Mobile Bay, Alabama reach 115–120 mm by end of first year.[5] At Beaufort, North Carolina average 20.2 mm in January (maximum 76–80 mm); 72.1 mm in June (maximum 100–118 mm); 143.4 mm in October (maximum 175–194 mm).[3] In Chesapeake Bay reach a modal length of 175–180 mm by fall.[15] In New Jersey average 40 mm first winter; 150 mm second winter; 220 mm third winter; 265 mm fourth winter.[2]

AGE AND SIZE AT MATURITY

South of Cape Hatteras mature as approach age I [13,14] at about 140–180 mm, survive only about 1 or 2 years; [6,13] north of Cape Hatteras mature as approach age II [2,12,13] at more than 200 mm [2,12,13] probably live for several years.[13]

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Pogonias cromis (Linnaeus), Black drum

ADULTS

D. X–I, 19 [18]–23; A. II, 5 [9]–7; [5,9] C. 9+8, procurrent rays 8–9+8; [10] V. I, 5; [16] scales 41–45 in a lateral series; [5] vertebrae 10+14; [9,10] gill rakers 4–6+12–16; branchiostegals 7; [16] teeth in jaws small, set in broad bands, none especially enlarged; [5] no teeth on vomer, palatines, or tongue; [16] lower pharyngeals large, completely united, with many blunt molars at the middle and surrounded with strong conical teeth (LNC).

Head 2.9–3.4,[5] depth 2.3 [16]–2.8, pectoral fin 3.3–3.6 in SL; snout 2.8 [5]–3.7,[16] eye 2.8–3.9, interorbital 3.0–4.0, maxillary 2.5 [5]–3.3 [16] in head.

Body oblong, moderately compressed, back much elevated; ventral outline nearly straight; head moderately short, snout blunt; mouth horizontal, inferior, lower jaw included; maxillary scarcely reaching below middle of eye; [5] chin with 5 pores and 12 to 13 pairs of barbels along inner edges of lower jaw (LNC), the series usually

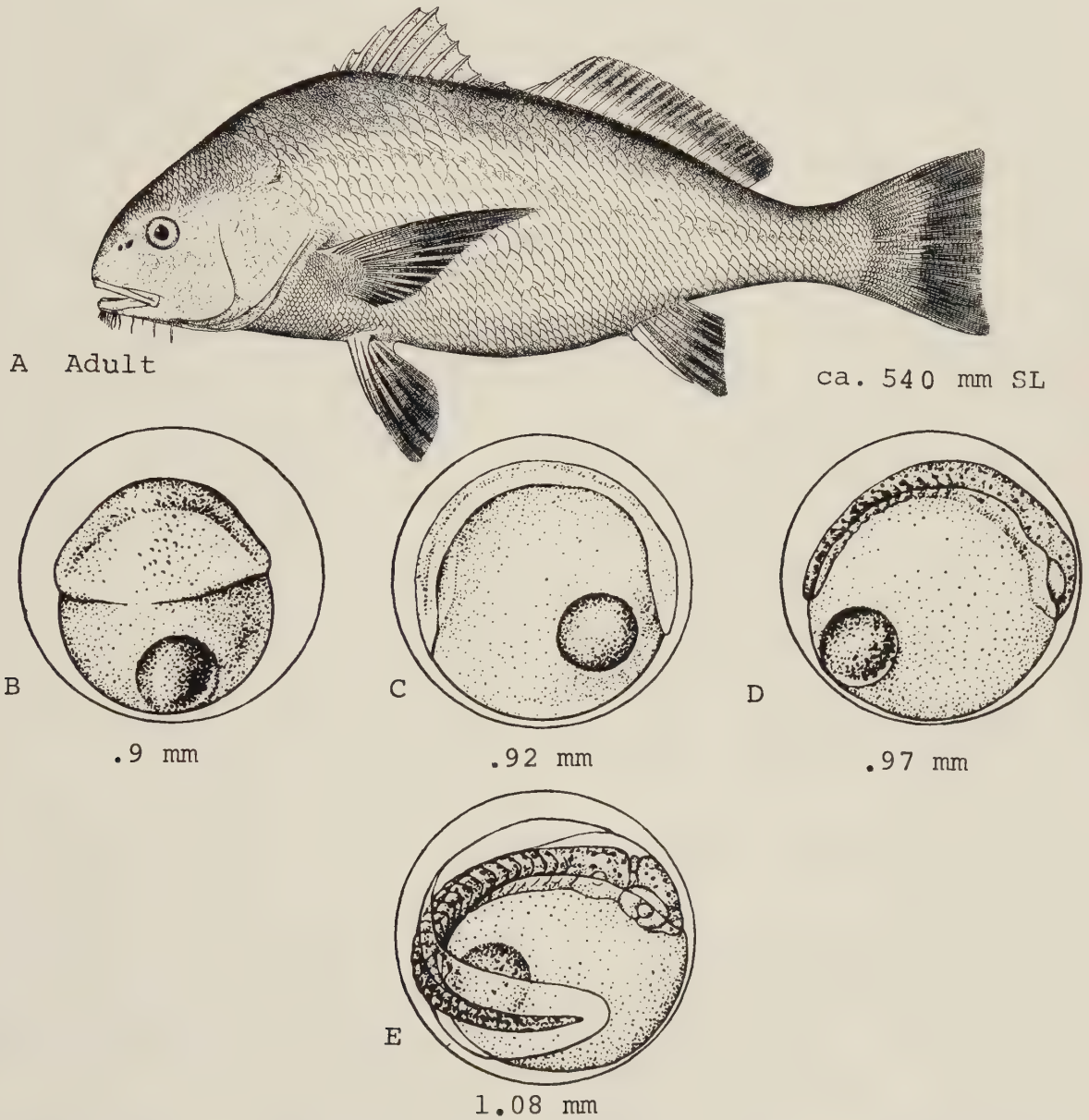

Fig. 138. *Pogonias cromis*, Black drum. A. Adult, ca. 540 mm SL. B.-E. Eggs in various stages of development. *(A, Goode, G. B., 1884: pl. 122. B-E, Joseph, E. B.,* et al., *1964: fig. 1.)*

extending back to below middle of eye.[4] Scales firm, ctenoid.[5] Dorsal fin continuous, with a deep notch in between the spinous and soft portions (LNC); dorsal spines stiff and slender, the third longest; anal fin short, the second spine much enlarged; caudal fin subtruncate; [5] pectoral fins about as long as head.[16]

Pigmentation: Color in life blackish with brassy luster, dark above (LNC); grayish white below; all fins dusky or black.[5] Color varies somewhat with habitat; in Gulf of Mexico almost uniformly silvery, lose crossbars early; in bays and lagoons darker, often bronze along back and dirty white on sides and belly.[2]

Easily recognized by numerous chin barbels, the entire preopercular margin, and the elevated back and straight ventral profile.[5]

Maximum size: Largest recorded 66.3 kg.[5,7]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Massachusetts to Argentina,[5] straying as far north as the Bay of Fundy; [17] largest numbers occur off the Texas coast in Corpus Christi Bay and Laguna Madre.[2]

Area distribution: Chesapeake Bay, Maryland and Virginia; [5,6] ocean coast of Virginia (LNC); Worcester County, Maryland; [12] New Jersey; [6,11] Delaware.[6]

Habitat and movements: Adults—common on sandy coasts [16] and in bays and lagoons where it frequents sandy areas and *Mytilus* beds.[15] Taken April–December in Chesapeake Bay area, most common May–November; [5] enter Delaware Bay from mid- to late April, generally leave during early June; [7] most abundant off Texas October–February,[14] migrate to Gulf passes to spawn from late January–May; [4] apparently move northward and inshore along northwest mid-Atlantic coast each spring and retreat southward and offshore by late fall.[8] May tolerate salinities of 10–85 ppt on Gulf coast, but usual range 25–50 ppt; [2] also reported as most abundant in Gulf coast at 10–15 ppt.[14] Taken at temperatures from 3–35 C.[2]

Larvae—after hatching, apparently carried into upper reaches of bays and tidal creeks by tidal currents; [3] specimens 1–6 mm taken February–April in Texas.[13]

Juveniles—preferred habitat during first 3 months apparently a muddy, nutrient-rich, marsh situation,[8] such as that found in tidal creeks and ditches; in Delaware River area taken in mid- to upper portion of marsh creeks, usually over a soft mud bottom, but occasionally over sand and gravel, generally in still areas; [7] remain in shallow bay and shore areas to about 100 mm when some move into deeper bay water and, to a lesser extent, offshore, however most remain to sexual maturity.[4] Taken July–October in Chesapeake and Delaware Bays, the smaller ones relatively uncommon in these areas; [6] first taken in Delaware River area in June, begin moving out of upper creeks in late June and early July at about 30–50 mm and mostly gone from there by end of October.[7] In Chesapeake and Delaware areas in salinities from 0–35 ppt, 43% between 10–20 ppt and 35% between 20–30 ppt; no relationship evident between size and salinity.[6] Taken at temperatures from 8.3–35.2 C; [7] died in captivity at 3.3 C.[6]

SPAWNING

Location: Some investigations indicate spawning takes place only off mouths of bays and lagoons,[4,6,13] however there appears to be good evidence of spawning in Delaware Bay,[7] at least lower parts of Chesapeake Bay [3] and in bays along the Gulf coast; [2] Chesapeake and Delaware areas probably northern limits of spawning range.[3,6] Larvae have not been taken in Chesapeake Bay, and it has been suggested that the major spawning may occur outside, with only a small number of larvae being carried into the estuaries, the remainder moving offshore or south to other estuaries, from where they migrate to Chesapeake and Delaware as adults; this theory remains unsubstantiated.[6]

Season: Probably spawn from March–May in Chesapeake and Delaware areas; [6] major months in Chesapeake Bay April–May; [3] peak in Delaware Bay about second to fourth week of May. Possibly a second spawning in Delaware area in September; [7] occurs in Everglades in late fall and winter; [1] on Gulf coast, ripe individuals found as early as December and as late as June, but 90% of known spawning occurs in February and March with a prolonged or split season in May or June [2] and possibly a late period from late July–November.[4] Mean temperature of 17.5 C$\pm$2.69 SD probably brackets spawning activity at mouth of Chesapeake Bay.[8]

Fecundity: 1110 mm female had about 6,000,000 eggs.[4]

EGGS

Pelagic; 0.816–1.020 mm in diameter. Oil globule multiple during cleavage and through germ ring stage in about half eggs; if multiple, most often 2 or 3, seldom more than 4, rarely 6; if multiple, diameter variable, if single, 0.22–0.26 mm; by time embryo visible, rarely more than 2, and at hatching only 1; located near anus of embryo. Pigment of oil globule in form of discrete black dots; pigment on embryo not distinctive but sparsely scattered over both dorsal and ventral surfaces in no apparent pattern; yolk surface and eyes unpigmented.[3]

EGG DEVELOPMENT

Hatch in 24 hours at 20 C.[3]

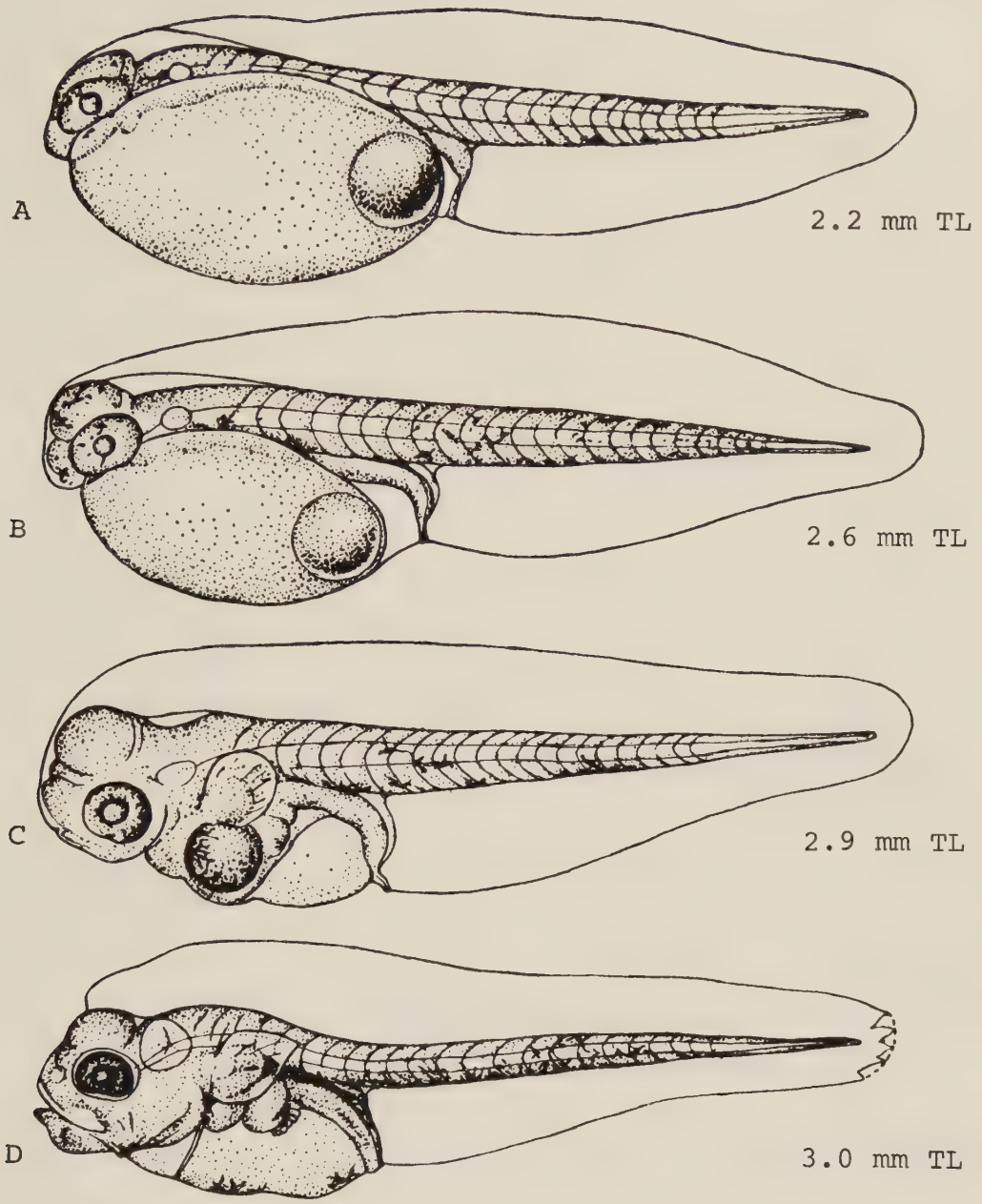

Fig. 139. *Pogonias cromis,* Black drum. A. Yolk-sac larva, 2.2 mm TL. B. Yolk-sac larva, 2.6 mm TL. C. Yolk-sac larva, 2.9 mm TL. D. Yolk-sac larva, 3.0 mm TL. (*A-D, Joseph, E. B.,* et al., *1964: fig. 2.*)

YOLK-SAC LARVAE

1.9–2.4 mm at hatching.

Oil globule near posterior margin of yolk sac. 12 hours after hatching snout extends beyond oval yolk sac; anus located a little behind yolk sac; no fins evident. At 2.8 mm yolk sac reduced and oil globule farther forward; pectoral fin buds present.[3]

Pigmentation: At 6–12 hours after hatching pigmentation of body indistinct and eyes still unpigmented; small chromatophores on head and sides of abdomen; a few chromatophores behind anus and concentrated in mid-caudal region, especially on dorsal and ventral sides. At 2.8 mm pigmentation on head and trunk more distinct; a group of ventral chromatophores present posterior to anus; 2 large branching chromatophores on midcaudal region, one dorsal, the other ventral; a smaller chromatophore halfway between midventral chromatophore and terminal myomere.[3]

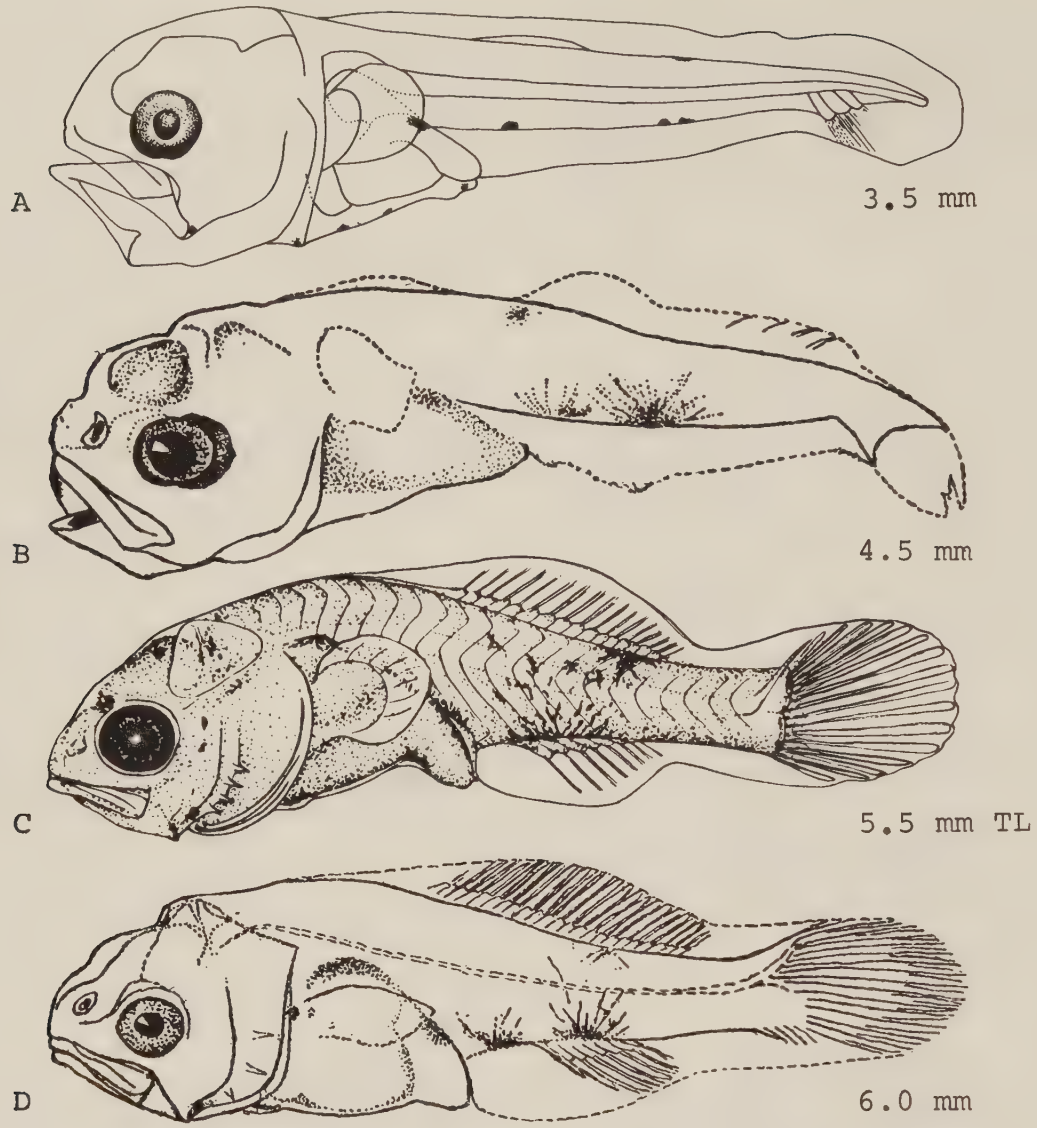

Fig. 140. *Pogonias cromis*, Black drum. A. Larva, 3.5 mm. B. Larva, 4.5 mm, should show 3–4 preopercular spines (HWP). C. Larva, 5.5 mm TL. D. Larva, 6.0 mm. (*A, Jannke, T. E., 1971: fig. 23 A. B, D, Pearson, J. C., 1929: figs. 13–14. C, Joseph, E. B.*, et al., *1964: fig. 3.*)

LARVAE

Specimens described 4.5–8 mm.

At 6 mm dorsal and ventral finfolds persist but now separate from tail, 6 anal rays discernible. At 8 mm dorsal and anal fins with full complement of rays. At 6 mm weak spines present on opercle.[4]

Pigmentation: At 4.5 mm 2 prominent groups of ventral chromatophores present, one slightly posterior to and above anus, the other approximately at base of undifferentiated anal fin (similar to the ventral ones in *Sciaenops ocellata*). At 6 mm 2 ventral chromatophores well marked. At about 8 mm black chromatophores present in profusion dorsally and along sides, tending to be arranged in definite groups extending from nape to caudal peduncle; these groups the forerunners of the vertical black bars that soon appear and remain to adult size, but all 6 rarely evident at this size.[4]

JUVENILES

At 15 mm general adult shape attained.

At 15–18 mm scales begin to develop posteriorly along lateral line; at 22 mm body fully scaled. At 13–14 mm

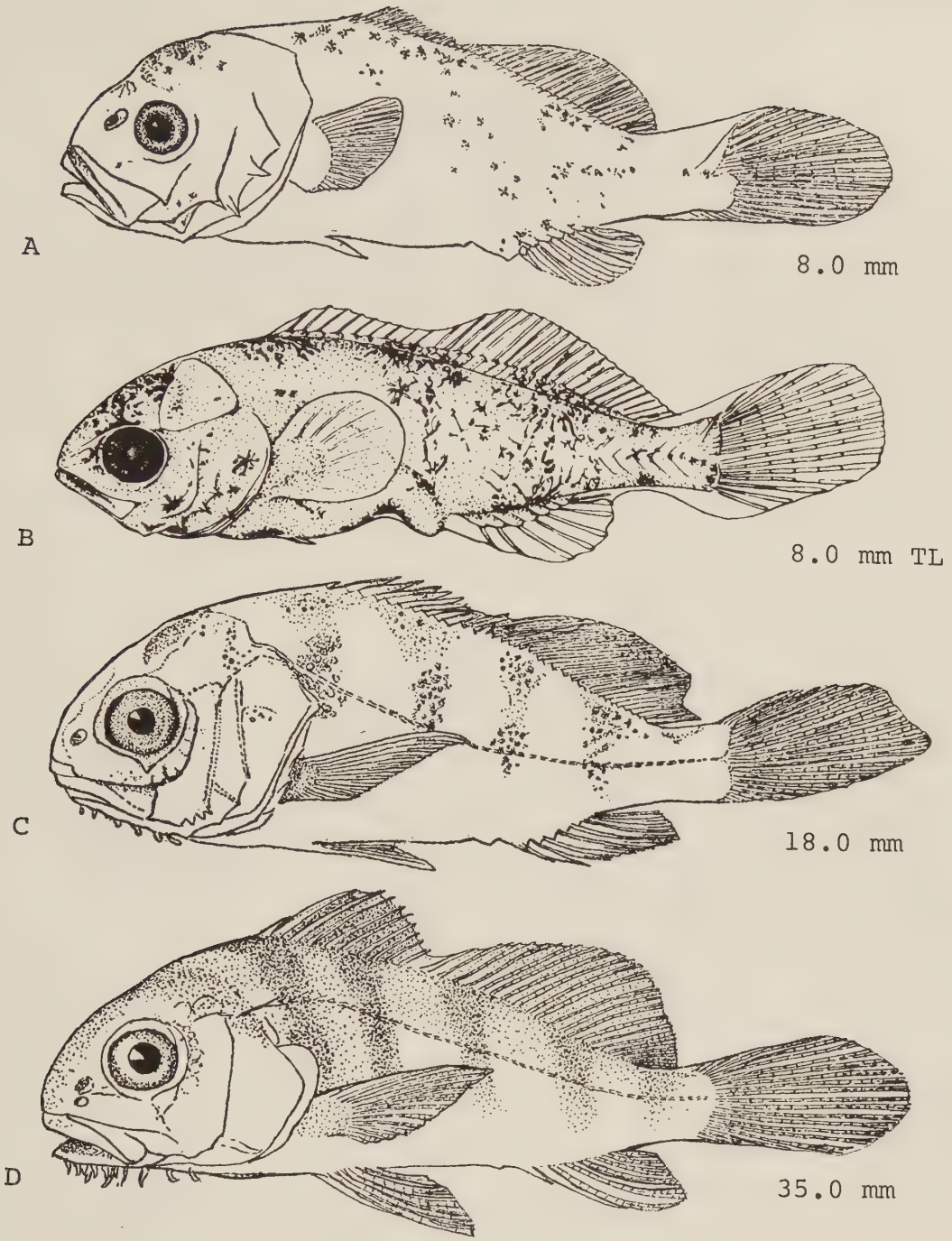

Fig. 141. *Pogonias cromis*, Black drum. A. Larva, 8.0 mm. B. Larva, 8.0 mm TL. C. Juvenile, 18.0 mm. D. Juvenile, 35.0 mm. (*A, C, D, Pearson, J. C., 1929: figs. 15–17. B, Joseph, E. B.*, et al., *1964: fig. 3.*)

ıbout 6 mandibular barbels present as small knobs on ower jaw; at 15–18 mm 11 barbels evident; at 22 mm .7 barbels evident.[7]

Pigmentation: At 12 mm pigmented areas on anterior nembrane of first dorsal fin, in front of this fin, and on lorsal surface of head. At 13–18 mm membrane of first lorsal fin darkly pigmented.[7] At 15 mm the 6 black bars pronounced, extending vertically from back to slightly below lateral line; all fins, except dorsal, colorless; color of body above lateral line light brown, marked with black vertical bars; a bright silvery sheen below lateral line. At 25 mm color pattern the same and pectoral and anal fins with a black cast. Entire fish becomes dark with age.[4] At about 170 mm back and sides silvery, dusky

Fig. 142. *Pogonias cromis*, Black drum. A. Juvenile, ca. 100 mm SL. B. Juvenile, 231 mm TL. (*A, Fowler, H. W., 1945: fig. 282. B, Goode, G. B., 1884: pl. 121.*)

white below; sides with 4–5 vertical black bars; all fins more or less dusky or black, except pectorals, which are plain; caudal sometimes plain translucent.[5]

GROWTH

Delaware River estuary during first year: June 6–10, 10.1–11.7 mm; June 23–28, 17.3–23.4 mm, July 14–19, 61.1–71.1 mm; August 18–23, 112.6–127.3 mm.[5] Chesapeake Bay, mean length for age groups: I, 223 mm; II, 406 mm; III, 562 mm.[8] Gulf of Mexico, size at end of successive years: first, 160[2]–250 mm;[4] second, 310[2]–370 mm;[4] third, 4.5 mm; about 50 mm/year after third year;[2] about 600 mm by fifth year.[4]

AGE AND SIZE AT MATURITY

Mature at end of second year at about 320 mm.[2,4]

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Sciaenops ocellata (Linnaeus), Red drum

ADULTS

D. X–I, 23–25;[14,23] A. II, 7[23]–8;[10,14,23] C. 9+8, procurrent rays 8–10+7[23]–10;[10] V. I, 5;[10] scales 40–45 in a lateral series;[14] vertebrae 10+15,[10,23] pleural ribs 8, epipleural ribs 7;[10] gills rakers 4–5+7–9;[25] branchiostegals 7;[24] teeth small conical in jaws, set in bands, outer row teeth of upper jaw slightly enlarged; lower jaw teeth subequal (LNC); no teeth on vomer, palatines, or tongue.[24]

Head 2.8–3.3, depth 3.3–3.9 in SL; snout 3.3–3.8, eye 3.1–4.7,[14] maxillary 2.5,[24] interorbital 3.7–4.6, pectoral fin 1.5–1.8 in head.[14]

Body elongate,[14] rather robust, not much compressed;[24] back moderately arched; ventral outline nearly straight; head rather long and low; snout conical; mouth horizontal, lower jaw included;[14] lower jaw with five pores, without barbels; maxillary almost reaching below posterior margin of eye (LNC). Scales rather large, strongly ctenoid;[14] no scales on soft dorsal fin;[14,24] scales of breast embedded, cycloid.[24] Dorsal fin continuous, with a deep notch between the spinous and soft portions (LNC); dorsal spines rather stiff, pungent; second anal spine thick, much shorter than longest soft rays; posterior margin of caudal fin straight to slightly concave; pectoral fin as long as pelvic fin. Preopercular margin serrate in smaller specimens, becoming entire in specimens of about 9–13 kg.[24]

Pigmentation: May be silvery, grayish, bronze, coppery, yellow, and sometimes almost black; often silvery or copperish in Gulf, darker in muddy bays;[6] each scale with a dark center, forming rather obscure, irregular, undulating brown stripes along scale rows;[14,24] one to several (most frequently 1) jet black spots at base of caudal and below the soft dorsal fin above lateral line;[6,14,24] dorsal and caudal fins dusky; anal and pelvic fins white; outer part of pectoral fin bright rusty.[14]

Maximum size: Largest recorded about 1274 mm and 37.3 kg.[15]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Gulf of Maine[7] to Tuxpan, Mexico;[4,12] probably not present as regular part of marine fauna north of New Jersey; along Atlantic coast most abundant in Florida; in Gulf of Mexico most abundant in Mississippi, Florida, and Texas.[12]

Area distribution: Chesapeake Bay, widespread in Maryland and Virginia;[8,14] Worcester County, Maryland;[17] ocean coast of Virginia;[19] Atlantic and Cape May counties, New Jersey.[16]

Habitat and movements: Adults—marine littoral, feeding on or off bottom;[20] normally stay close to shore but schools have been sighted in Gulf as far as 22 km offshore, and a few caught on Gulf reefs;[6,14] after first spawning spend increasingly more time in sea and less in bays and estuaries;[12] some may stay in surf most of year except for short periods in lagoons and back bays;[11] during ebb tides, seek shallow grassy areas lining channels, apparently to avoid being carried offshore.[21] Appear in New Jersey in late May or early June and remain until October;[3] taken May–October in Chesapeake Bay, most abundant during spring and fall;[14] taken April–October along ocean beaches and marsh areas of Virginia;[19] in Virginia and North Carolina, possibly a northward movement in spring and a southward movement in fall, with wintering over just south of Cape Hatteras;[12] present throughout year on Gulf coast, but greatest concentration mid-August to December, when spawning;[9] taken in surf in Texas, September–April;[11] movements on Gulf coast random, little interplay between bays or between bays and Gulf, but a general Gulfward migration in late fall and a bayward movement in spring.[4] Euryhaline;[6] taken in salinities from 0[6]–50 ppt, most abundant in Laguna Madre of Texas at 30–35 ppt.[22] Taken at temperatures from 2–33 C.[4] Older specimens apparently more sensitive to cold, but less sensitive to hypersalinity.[12]

Larvae—planktonic; hypothesized that they are carried from Atlantic Ocean spawning area into Chesapeake Bay by net upstream movement of high density, deep, subsurface water currents;[8] in Gulf, may be carried into estuaries by tidal currents;[5,12] in southwest Florida, some evidence indicates move in surface layers of flooding tides after dark.[2] At Cedar Bayou inlet, Texas, taken mid-August or September to late October.[21]

Juveniles—early juveniles prefer clumps of grass or oyster shell over slightly muddy bottoms in quiet, protected waters,[4,5,6] generally less than 2 m;[8] later scatter over flats, channels, and reefs and may move outside;[6] at Cedar Key, Florida most abundant in open water, outer pools, and water courses, in that order;[20] on Gulf coast some apparently move outside bay when less than one year old and never re-enter.[4] First appear in Chesapeake Bay in mid-September; 20–50 mm specimens taken in September, 20–75 mm in October, 30[8]–90[14] mm in November; 20–90 mm specimens restricted to a shoal estuarine habitat during fall months, may then rapidly descend to deeper water or ocean in early winter; never taken in bay December–February.[8] Taken April–July and November in St. John's River, Florida;[18] absent from Tampa Bay area June–October.[1] In Texas first appear in primary bays in August, but not in Laguna Madre until February;[4] specimens 5–60 mm abundant in shallow waters October–November; specimens 50–150

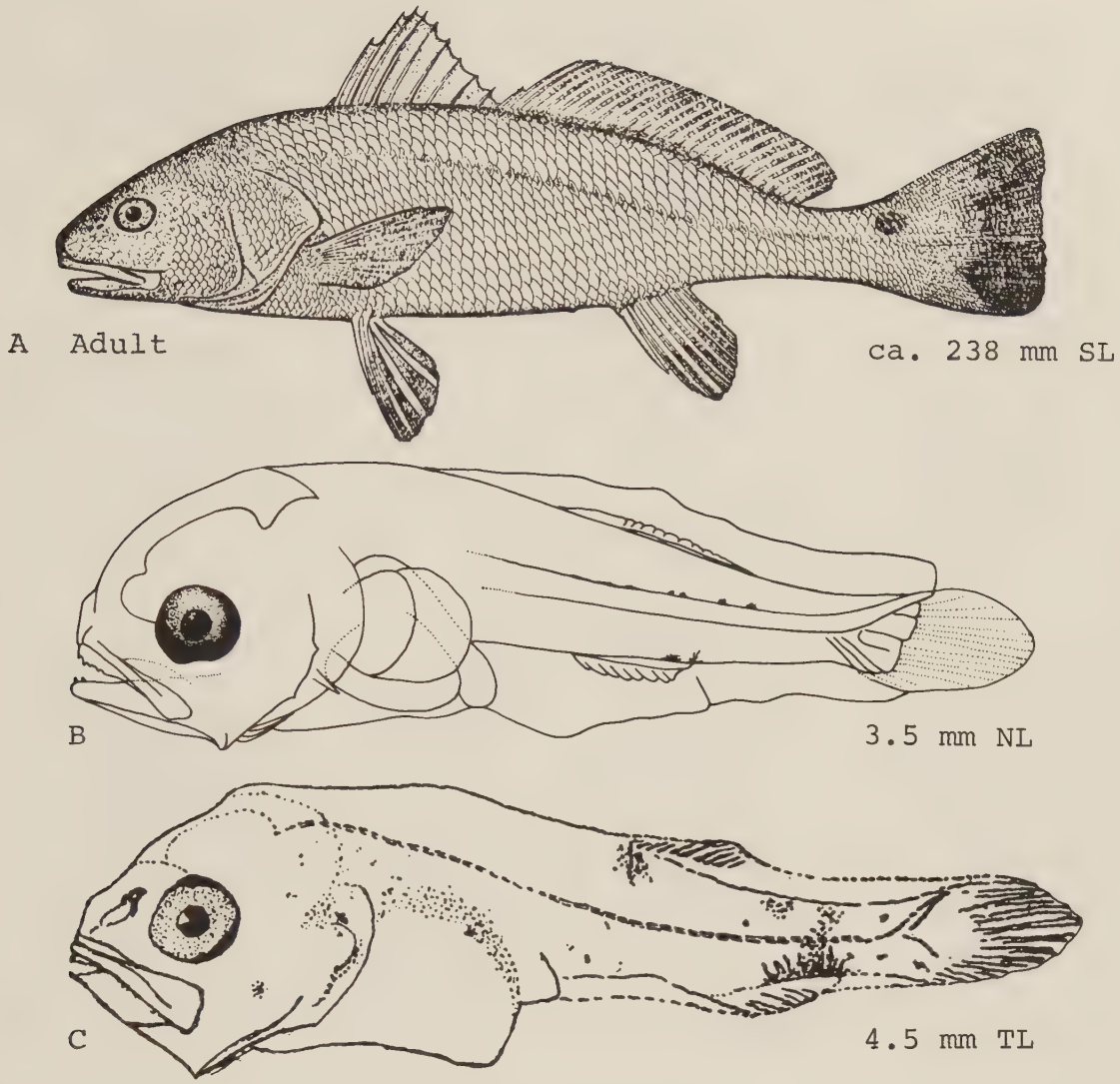

Fig. 143. *Sciaenops ocellata,* Red drum. A. Adult, ca. 238 mm SL. B. Larva, 3.5 mm NL, most characteristic pigment areas (except notochord pigment) not indicated (HWP). C. Larva, 4.5 mm TL, preopercular spines not shown, pigment adequate except for omission of notochord pigment (HWP). (*A, Goode, G. B., 1884: pl. 125. B, Jannke, T. E., 1971: fig. 24A. C, Pearson, J. C., 1929: fig. 3, modified slightly.*)

mm move into deeper waters during cold weather; year old specimens found within bays and lagoons as much as 130 km from nearest passes.[5] Taken in salinities from 0[18]–45 ppt;[22] in Chesapeake Bay taken between 14–22 ppt; at Cedar Key, Florida more than half taken between 25–30 ppt.[20] Taken in temperatures from 10–30 C.[12]

SPAWNING

Location: Apparently occurs primarily on outer coasts near passes and channels.[4,5,6,11,12] but may not be entirely confined to passes;[6] probably occurs along Atlantic coast from Virginia southward to at least St. Lucie inlet in Florida[12] (no evidence of spawning north of Chesapeake Bay[3]); in Gulf of Mexico apparently occur from Cape Sable, Florida to northern coast of Mexico.[12]

Season: May begin in July (and possibly earlier) and continues at least through December, with a peak in late September or October;[12] on Atlantic coast starts earlier[5,12] and lasts about a month longer than on Gulf coast.[12] On Gulf coast generally begins in September[2,3,5,9,12,13] and extends to mid-November[5,13] with a peak in October;[5,12,13,21] some evidence of a longer season, beginning as early as August[6] and extending to January[6,12] or February.[2]

Fecundity: 750–825 mm specimens had about 2.5 million eggs;[11] 900 mm specimen had about 3.5 million eggs.[5]

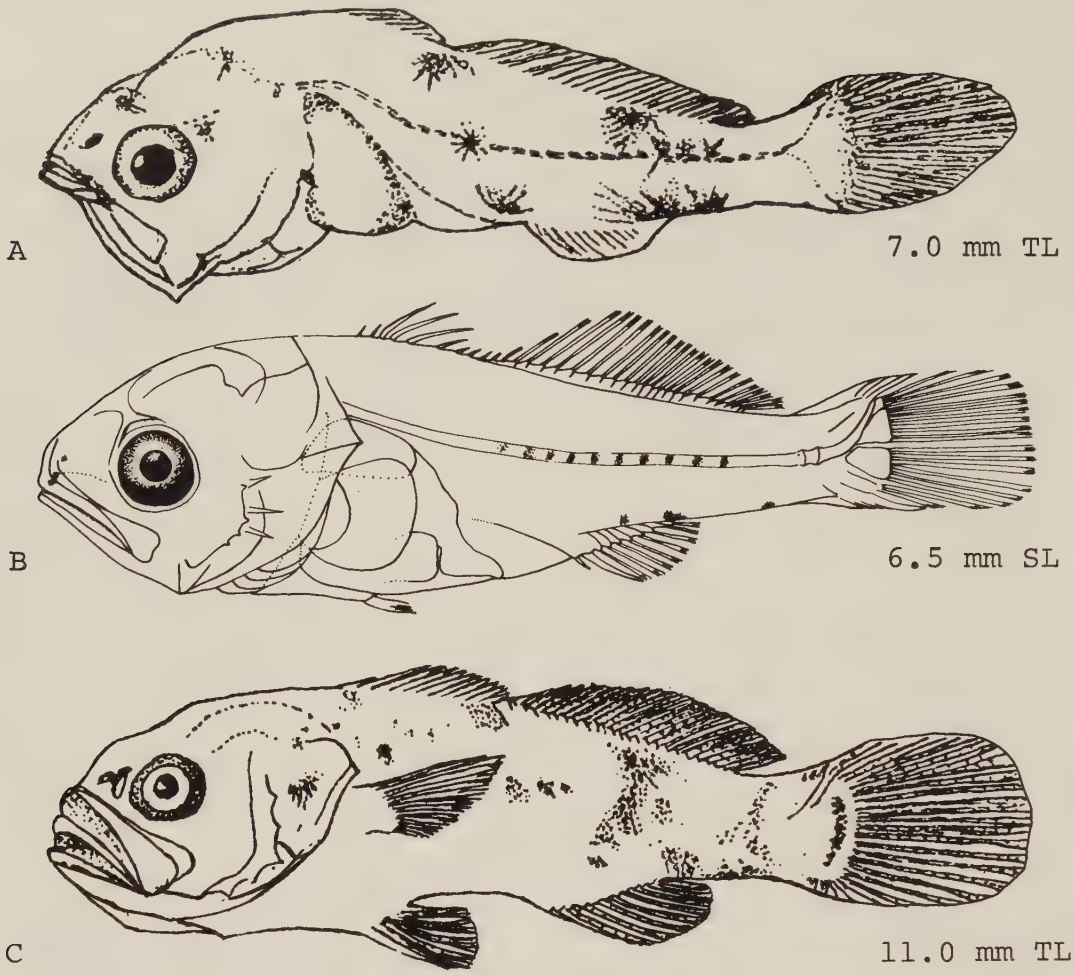

Fig. 144. *Sciaenops ocellata,* Red drum. A. Larva, 7.0 mm TL, preopercular spines not shown (HWP). B. Larva, 6.5 mm SL, note notochord pigment spots. C. Juvenile, 11.0 mm TL. (*A, C, Pearson, J. C., 1929: figs. 4–5. B, Jannke, T. E., 1971: fig. 24B.*)

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

Specimens described 4–7.9 mm.

At 4–5 mm finfold well developed, dorsal and anal fins not distinct; pectoral present throughout development and pelvic fins not evident. At about 7 mm only a small membrane between anus and anal fin remaining on finfold.[5]

Pigmentation: At 4–5 mm one or several prominent groups of melanophores or pigment patches present, one ventrally along posterior end of anal fin base, one at origin of the second dorsal fin, and one ventral, slightly posterior to anus.[5] Internal pigment along notochord, suggested in several drawings, often pronounced in specimens 4.1–7.9 mm; about 10 marks from anus to caudal peduncle providing a good character for identification (HWP).

Can usually be distinguished at this stage from *Micropogonias undulatus* by presence of dorsal chromatophores, and wider spacing of the ventral ones.[5] Usually separable from *Pogonias cromis,* which are not generally taken at same time of year, by presence of melanophores along notochord (HWP).

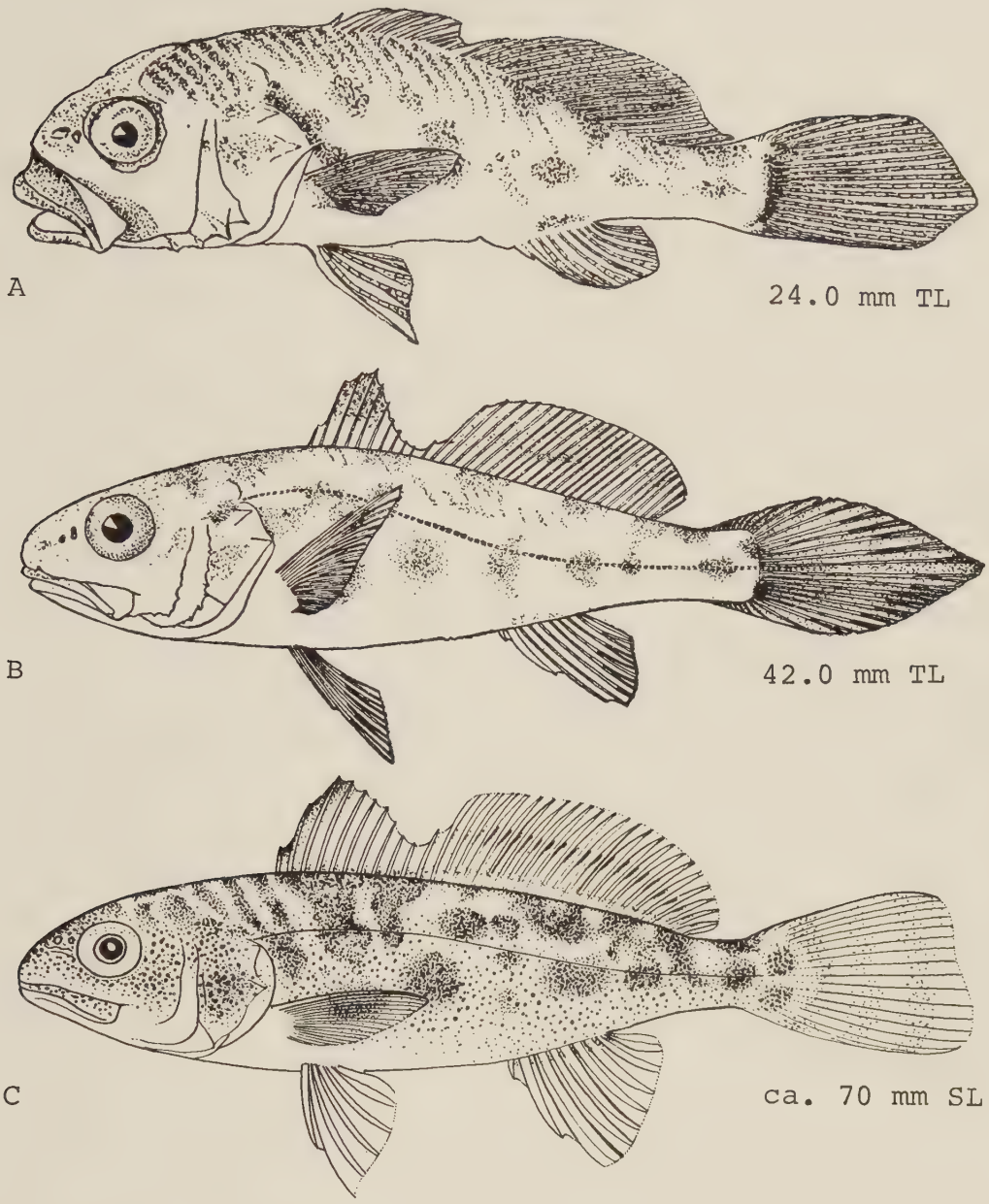

Fig. 145. *Sciaenops ocellata,* Red drum. A. Juvenile, 24.0 mm TL. B. Juvenile, 42.0 mm TL. C. Juvenile, ca. 70 mm SL. (*A, B, Pearson, J. C., 1929: figs. 6–7. C, Fowler, H. W., 1945: fig. 21.*)

JUVENILES

Specimens described 25–150 mm.

At 25 mm scales and teeth evident.[5]

Pigmentation: At 25–40 mm color pattern quite distinctive; ground color pale brown, somewhat silvery in fresh specimens; a distinct row of 5–7 brown blotches, usually smaller than eye, along lateral line, one on opercle, one behind, 2 or 3 under dorsal fin, and one on caudal peduncle; a fainter row of these blotches along back from nape to caudal peduncle, the number varying; series of dark brown pigment dots along base of caudal fin, and a series of chromatophores along base of anal fin; membrane of spinous dorsal punctulate with dark brown; soft dorsal with similar, less distinct markings.[3,5] At 36 mm a pronounced chromatophore enlargement occurs dorsolaterally at base of caudal fin, which is the first appearance of the ocellated black spot characteristic of the adult [5] (however, it is elsewhere reported that this spot is not evident until 50 [4]–60 mm [3]). Brown lateral blotches generally remain to about 150 mm,[5] but becoming less distinct by 120 mm and may be lost earlier.[5,14]

Characterized by absence of chin barbels and presence of

one or more spots at base of upper part of caudal fin; [14] pectoral fin more pointed than that of *Micropogonias undulatus,* caudal fin less pointed.[4]

GROWTH

Various growth estimates based on Texas specimens: 320–360 mm by end of first year, 500 mm second year, 550–600 mm third year, 875 mm sixth year, 925 mm seventh year, 975–1000 mm eighth year; [11] modally 340 mm by end of first year, 540 mm second year, 640 mm third year, 750 mm fourth year, 840 mm fifth year; [5] 330–356 mm by end of first year; 484–559 mm second year, 660–762 mm third year, probably about 890–965 mm by fourth year or fifth year.[6] Growth during first year at Cedar Key, Florida, about 46 mm by late November, 100 mm by March; [20] in Chesapeake Bay about 50 mm reached by mid-March.[3]

AGE AND SIZE AT MATURITY

Mature at end of third or fourth [4,6] to fourth or fifth [5] year; 5 year old fish constitute bulk of spawning population. Generally mature at about 700–800 mm,[4,11] but ripe fish as small as about 400 [12]–450 mm occasionally found.[4]

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Stellifer lanceolatus (Holbrook), Star drum

ADULTS

D. XI [8,13] to XII [8,12]–I, 20 [13,15]–24; [2,8] A. II, 7–9; [8] C. 9+8, procurrent rays 7–9+6–9; [8] V. I, 5; [13] scales about 47–50 in a lateral series; [2] vertebrae 10+15 [8] or 11+15; gill rakers 10–13+22–23; [15] teeth small, conical, set in narrow bands in jaws, outer row teeth in upper jaw slightly enlarged (LNC); no teeth on vomer, palatines or tongue.[13]

Head 3.2 [13]–3.4, depth 2.7 [12]–3.5 [13] in SL; snout 3.5 [12]–4.3,[13] eye 4.0 [12]–4.3,[13] interorbital 2.4 [12]–3.0,[13] maxillary 2.2, pectoral fin 1.0 [12]–1.6 [13] in head.

Body oblong, compressed; [2] head strongly cavernous (spongy to touch) somewhat depressed at nape (LNC); snout blunt and almost as broad as deep at anterior margin of eye; mouth oblique, its tip below level of lower margin of eye; [2] maxillary reaching about to posterior margin of pupil. Scales ctenoid, extending more or less onto all fins.[12] Dorsal fin continuous with a deep notch between the spinous and soft portions (LNC); dorsal spines slender, flexible, second anal spine enlarged; caudal fin lanceolate. Preopercular margin with small spines.[12]

Pigmentation: Grayish olive above, silvery below; numerous black dots on sides; [13] fins translucent [12] or uniform dusky; [13] spinous dorsal with black margin; [12] base of anal fin and inner lining of opercle dusky.[13]
Easily recognized by cavernous (or spongy) head (LNC), broad interorbital, blunt snout, slightly concave dorsal outline of head, terminal or slightly inferior mouth.[2]

Maximum size: Reaching a maximum of about 170 mm; [5] average size about 100–130 mm.[1]

DISTRIBUTION AND ECOLOGY

Range: Western Atlantic from Chesapeake Bay [12] to Florida and the northern Gulf of Mexico; [9] not common north of South Carolina; [12] one of the most abundant bottom fishes on the South Atlantic and Gulf coasts.[1,7]

Area distribution: Chesapeake Bay at Lynnhaven Roads, Virginia.[12]

Habitat and movements: Adults—found on sand or mud bottoms from a few meters [1] to at least 27 m; [4] found both inside bays and on outer coast, mostly the latter, as prefer higher salinities; [5] at Beaufort, taken near shore to about 20 km offshore.[2] Taken off Louisiana every month except January and May; [3] a year round resident at Beaufort, North Carolina, but much more numerous in summer than winter; [2] taken every month off Texas, most abundant in April; [11] most abundant in Texas bays in late fall and spring, none taken in bays in January and February.[5] Taken in salinities from 0.2–36.8 ppt, mostly taken above 30 ppt, and very few taken below 10 ppt; [5] taken at temperatures from 8.6 [16]–34.9 C.[3]

Larvae—at Beaufort, specimens under 5 mm taken on bottom in July, August, and September, in same general vicinity where adults occur year round; specimens 4–11 mm taken in plankton at Port Aransas, Texas, June–September.[14]

Juveniles—found on bottom in same general vicinity as adults.[2]

SPAWNING

Location: Apparently occurs in same general vicinity

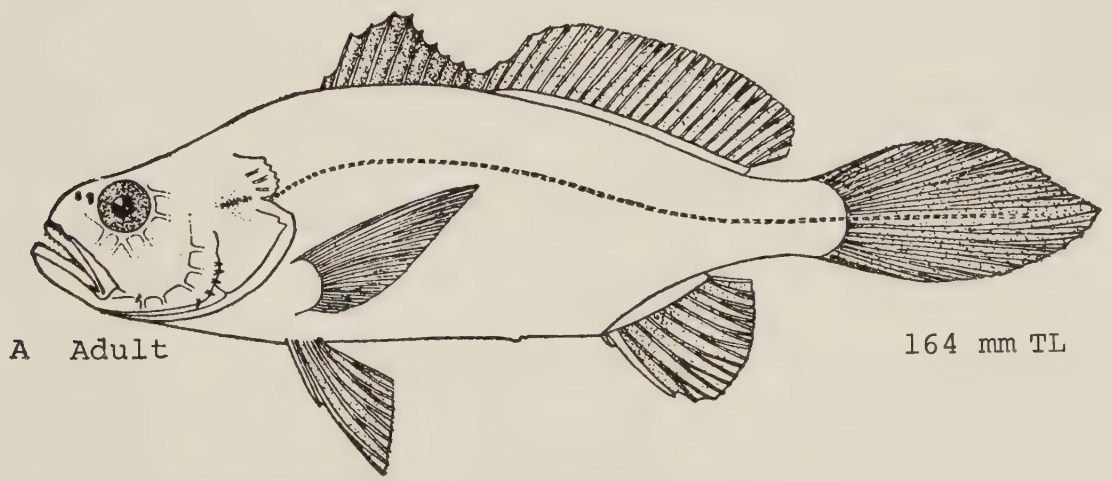

Fig. 146. *Stellifer lanceolatus*, Star drum. A. Adult, 164 mm TL. (*Welsh, W. W., and C. M. Breder, Jr., 1923: fig. 36.*)

occupied by adults year round.[2]

Season: Probably extends from May–August at Beaufort; [2] May and June the principal months on the Atlantic coast; [1] occurs in spring and summer in Gulf of Mexico; [10,14] ripe individuals taken in August at Beaufort,[2] April, May and June in Louisiana,[6] and May in Texas; 42 and 70 mm specimens taken in Texas in February indicate the possibility of a late summer spawning.[11]

Salinity and temperature: Ripe females taken in Texas at 28.5–30.7 ppt and 20.5–20.9 C.[5]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

Note: *The Hildebrand and Cable (1934) descriptions of specimens 1.8–2.0 mm, 2.5 mm and 3.0–3.5 mm are based at least in part on misidentified specimens of* Larimus fasciatus. *Therefore, much of the description of these sizes has been deleted (included under account of* Larimus fasciatus) *and only that appropriate for* Stellifer *is given as per recommendations of* HWP.

1.8–2 mm or smaller to about 10–13 mm.

At 3–3.5 mm soft dorsal fin base well defined, but rays not fully differentiated, spinous dorsal not evident; at 4.5–5.5 mm about 22 rays in soft dorsal, no spines; at 7–8 mm dorsal fin with full complement of spines and soft rays. At 3–3.5 mm anal fin base well defined, but rays not fully differentiated; at 4.5–5.5 mm about 10 rays present; at 7–8 mm full complement of spines and soft rays present. At 2.5 mm slight indication of caudal rays; at 3–3.5 mm some fin rays well developed; at 4.5–5.5 mm caudal fin moderately long and somewhat pointed. At 3–5.5 mm pelvic fins not evident or present only as tufts of membrane; at 7–8 mm better developed but still small. At 7–8 mm a slight concavity remains in ventral outline of body between anus and anal fin origin, occupied by a remnant of the finfold, the body thin and translucent just above this. At 4.5–8 mm snout to anus 2.0–2.3, anus to base of caudal 1.8–2.1, depth 2.6–2.8 in SL.[2] Body depth usually less than 40%, preanal distance less than 47% throughout development (HWP). At 2.5 mm about 8 preanal + 17 postanal myomeres. At 2.5 mm teeth present in jaws. At 3–3.5 mm notochord flexes.[2] Distinct spines present on preopercular margin throughout development (HWP).

Pigmentation: At 4.5–5.5 mm a few dark points present on vertical midline of chest and abdomen; an elongate black spot present at end of anal base, variable in size and intensity; a small dark spot evident in some at anal origin; diffuse dark pigment is present on the dorsal surface of the airbladder; a faint dark bar present at base of caudal fin. At 7–8 mm pigmentation somewhat variable; generally a few dark dots on median line of chest and abdomen; spot at end of anal base persists; some with 2 spots at and behind anal base, each may have a narrow vertical projection; some with a small black spot near anal origin; a rather prominent dark spot above anus, often more or less connected with other spots, reaching to a diffuse pigment area on dorsal surface of airbladder; a narrow dark bar at base of caudal evident.[2]

JUVENILES

About 10–13 mm and larger.

At 10–13 mm pelvic fin well developed; caudal fin remains long and pointed, longest rays longer than head. At 10–13 mm slight concavity in ventral outline between anus and anal fin origin still evident, absent by 25–30 mm. At 10–13 mm snout to anus 1.8–2.0, anus to base of caudal 2.0–2.1, body depth 2.6–2.7 in SL; at 10–20 mm head 2.5–2.7 in SL, snout 4.6–5.5 in head; at 25–30 mm head 2.8–2.9 in SL, depth 2.7–3.1 in SL, snout 4.2–4.5 in head, maxillary 1.8–1.9 in head. At 18–20 mm preopercular margin with 3–4 small spines, interopercle with 3 embedded bony stays, postemporal serrate; at 45–50 mm preopercular and postemporal spines smaller.[2]

Pigmentation: At 10–13 mm some specimens with a series of 3–7 dark spots on side below spinous dorsal and several on posterior part of head and on nape.[2] At 15 mm preserved specimens pale with a few small black punctulations on top of head and nape, a patch of blackish chromatophores at dorsal end of opercular flap where it joins body (may be present as early as 7.4 mm SL and is diagnostic for *Stellifer*, HWP), a patch on side beneath spinous dorsal and 3–4 single black chromatophores on ventral line of caudal peduncle.[1] At 18–20 mm pigmentation considerably advanced; dark spot near end of anal base still evident, preceded and followed by a row of dark dots and spots; the characteristic, elongate, slightly arched spot on opercle, immediately in advance of upper angle of gill opening, remains prominent; mouth margined with black and numerous dusky markings occur on head, nape and upper part of sides variable in size and intensity; one row of spots follows base of dorsal fin and another parallels it about an eye diameter lower on side; other scattered markings present and a dark bar at base of caudal.[2] At 25–30 mm a dark band

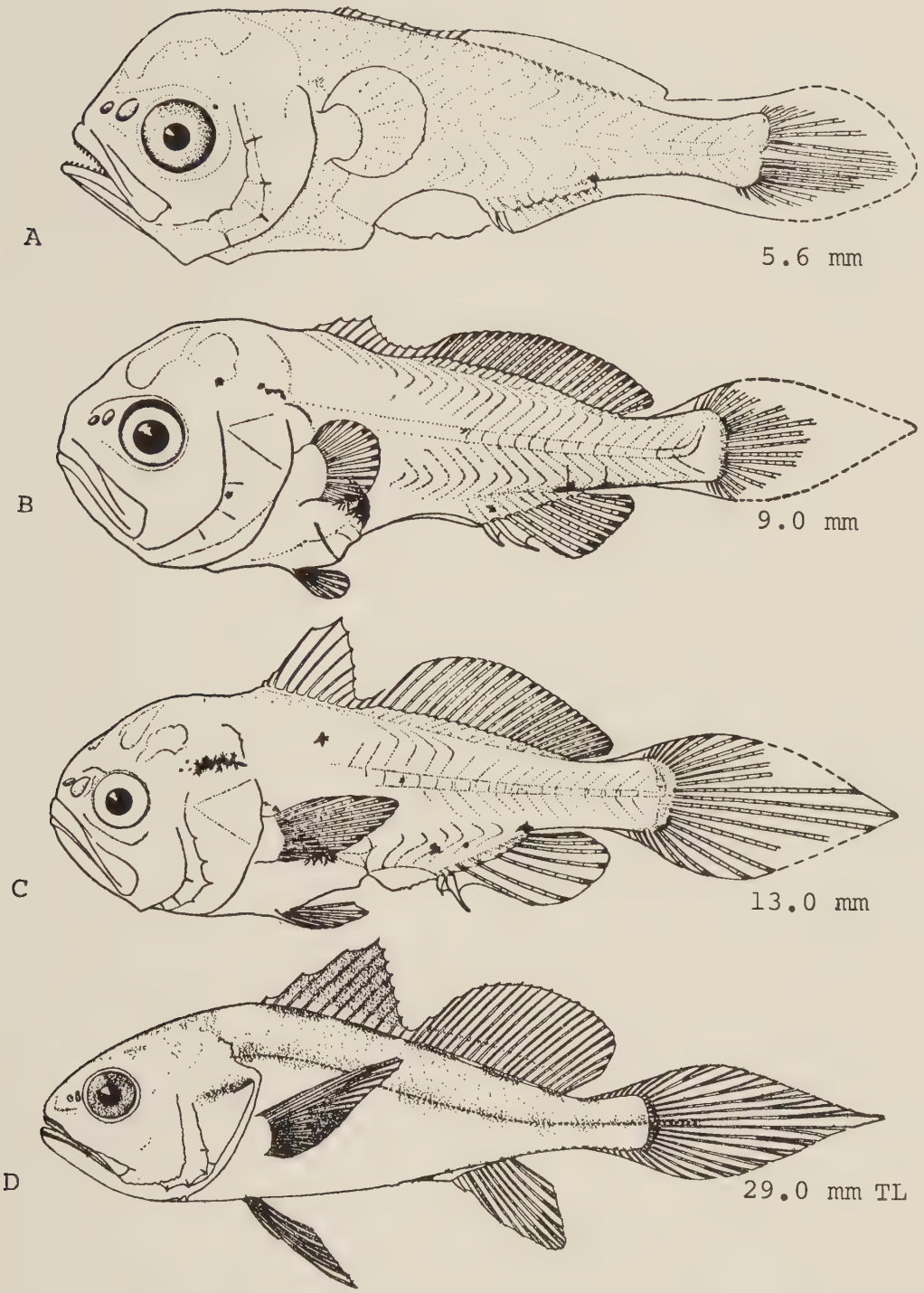

Fig. 147. *Stellifer lanceolatus*, Star drum. A. Larva, 5.6 mm. B. Larva, 9.0 mm. C. Juvenile, 13.0 mm. D. Juvenile, 29.0 mm TL. (*A-C, Hildebrand, S. F., and L. E. Cable, 1934: figs. 22–24. D, Welsh, W. W., and C. M. Breder, Jr., 1923: fig. 35.*) *Figs. A, B, and C show body form and fin development adequately, but some pigmentation is lacking (HWP). Earlier stages illustrated by Hildebrand and Cable (1934) are not included, as they do not agree with description.*

or series of blotches on body just below dorsal fin; membrane of spinous dorsal punctulate with brown; premaxillary and mandible edged with blackish; opercular spot conspicuous, with a few groups of small black chromatophores behind it; a dark vertical bar at base of caudal rays and a row of black chromatophores on ventral side of caudal peduncle.[1] At 40–50 mm pigmentation general; back of preserved specimens light brown and lower parts silvery; elongate dark spot on upper part of opercle and dusky color around mouth remain; dark blotches along back generally persist, but are less distinct; spinous dorsal dusky and all other fins with some dots; dusky bar remains at base of caudal fin. At 75–85 mm about same as 40–50 mm; dark points more numerous; anal fin and tips of pelvics quite dusky.[2]

GROWTH

In Texas reach 83–118 mm in first year; may reach 100–125 mm in first year;[2] life cycle probably short.[5,6]

AGE AND SIZE AT MATURITY

In Texas, reach maturity early in second year.[5] Mature by about 80 mm.[1]

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Mullus auratus
Pseudupeneus maculatus

goatfishes
Mullidae

FAMILY MULLIDAE

The Mullidae includes about 50 species in six genera distributed worldwide in tropical inshore waters, a few ranging into temperate waters. Goatfishes typically inhabit relatively shallow water where they are generally associated with sand or mud bottoms. Four species, each in a different genus, occur in the western Atlantic, and two have been recorded from the Chesapeake Bay region.

The goatfishes are characterized by the possession of a pair of long, unbranched chin barbels carried in a median groove in the throat. These barbels are moved rapidly and extended over and through the sediment during feeding, serving in a tactile and chemosensory capacity. Goatfishes feed primarily on small benthic invertebrates. Other significant characters of the Mullidae are as follows: Spinous and soft dorsal fins separate; the first ray in the second dorsal fin and the second ray in the anal fin usually transitional spines (segmented distally but not bilateral or branched); pelvic fin I, 5, pelvic axillary process well developed; small teeth present in jaws, present or absent on vomer and palatines; branchiostegals 3; subocular shelf present on second suborbital; supramaxillary absent; vertebrae 10+14; principal caudal rays 8+7; procurrent spur absent (GDJ).

There is little known about reproduction in this family. In two European species, *Mullus surmuletus* and *Mullus barbatus*, spawning occurs in early summer and the eggs are pelagic. The latter undergoes an extensive spawning migration in the spring (Breder and Rosen, 1966).

Juveniles of at least some species of goatfishes have an early pelagic stage which differs in body shape and coloration from a later inshore stage. Caldwell (1962) described this transformation for three of the four western Atlantic species (including the two treated here). The major physical changes involved in the transition from a pelagic to a benthic mode of life are the replacement of the silvery or dark brown pelagic coloration with the adult coloration, the development of a more robust body shape and the loss of the deciduous nature of the scales.

Mullus auratus Jordan and Gilbert, Red goatfish

ADULTS

D. VIII–I, 8; [1,3] A. II, 6; [1,2] C. 8+7,[1,3] procurrent rays 9+9; [3] P. 15–17; V. I, 5; lateral line scales 29–35; [1] vertebrae 10+14; [3] gill rakers 18–21 on first arch; branchiostegals 3. Teeth in upper jaw absent or not visible; in lower jaw a single row of small canines becoming irregularly biserial anteriorly; fused palato-vomerine bone with 2 patches of approximately 55 peg-like teeth each.[1]

Head 3.4, depth 3.7–4.0 in SL; eye 3.7, snout 2.6, maxillary 2.7, pectoral fin 1.4, pelvic fin 1.3 in head.[2]

Body elongate, slightly compressed; maxillary extending to exactly opposite front of eye. Scales large, slightly ctenoid. Lateral line continuous, with branched pores. Dorsal fins completely separate; dorsal spines slender, compressed, the longest about 1.6 in head; height of soft dorsal half head; [2] first ray of second dorsal and second anal ray transitional spines (segmented distally, but not bilateral or branched); [1] caudal fin as long as head. Gill rakers slender, a little shorter than pupil. Throat with 2 long unbranched barbels (modified branchiostegals). Opercle without spines.[2] Upper wing of cleithrum smooth.[1]

Pigmentation: Color in life scarlet to crimson, sides with 2 distinct longitudinal yellow stripes; first dorsal fin pale with an orange band at base and a yellow band distally; second dorsal fin mottled scarlet and pale; anal and pelvic fins plain; caudal fin scarlet; pectoral fins reddish: iris violet, dusky above; sides of head silvery.[27] Color after 13 days in formalin head red, sides red above lateral midline, shading to silvery abdomen; bright red stripe along midline, below which are 2 yellow stripes; pectoral fins pink with 4 faint stripes; pelvic fins clear with 4 yellow stripes; anal fin yellow; first dorsal fin clear with 2 stripes, upper bright orange, lower yellow; second dorsal fin with 4 stripes, yellow flecked with black; dorsal half of caudal fin with 7 or 8 faint bars, some bright red, some orange, and some yellow; ventral half of caudal fin with indeterminate number of faint bars. After long period in preservative, specimen pale yellow with no distinctive markings.[1]

Maximum size: Reported to reach 200 mm.[2,7]

DISTRIBUTION AND ECOLOGY

Range: East coast of North America from Nova Scotia and Bermuda to the West Indies and throughout the Gulf of Mexico; [4] rare north of Cape Cod.[7]

Area distribution: Metomkin Inlet, Virginia; [5] Atlantic and Monmouth counties, New Jersey.[6]

Habitat and movements: Adults—characteristic of mud or silty sand bottoms in deeper water.[9]

Larvae—no information.

Juveniles—two stages, a pelagic one occurring at the surface and a bottom living one taken only by bottom trawl; pelagic mode terminates at about 45 mm; not taken as deep as *Pseudupeneus maculatus* indicating juveniles prefer shallower water or adults do not spawn in or close to deep water.[1] A 58 mm specimen taken at Metomkin Inlet, Virginia at 31.8 ppt and 23.6 C.[5]

SPAWNING

Juveniles collected between January and May; smallest specimen (8 mm) taken in April.[1]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

9.5 mm or less and larger.

At 9 mm last dorsal fin ray branched; at 11.9 mm no rays segmented; at 14.5 mm last eight rays segmented; at 40 mm branching complete; at 47 mm first ray segmented. At 8.2 mm last anal fin ray branched; at 14 mm segmentation begins; at 16 mm segmentation complete; at 21 mm branching complete. At 9.3 mm all principal caudal fin rays segmented; at 14 mm innermost rays begin to branch; at 18.7 branching complete. At 9 mm 5 dorsal and 4 ventral procurrent caudal fin rays all unsegmented, at 10.9 mm eight procurrent rays in each lobe, all unsegmented; at 14.5 mm first dorsal and first ventral procurrent rays segmented; at 45 mm second dorsal and ventral procurrent rays segmented as in adult. At 25 mm third pectoral fin ray segmented, no rays branched; at 27 mm fourth through seventh rays branched; at 47 mm segmentation complete, branching

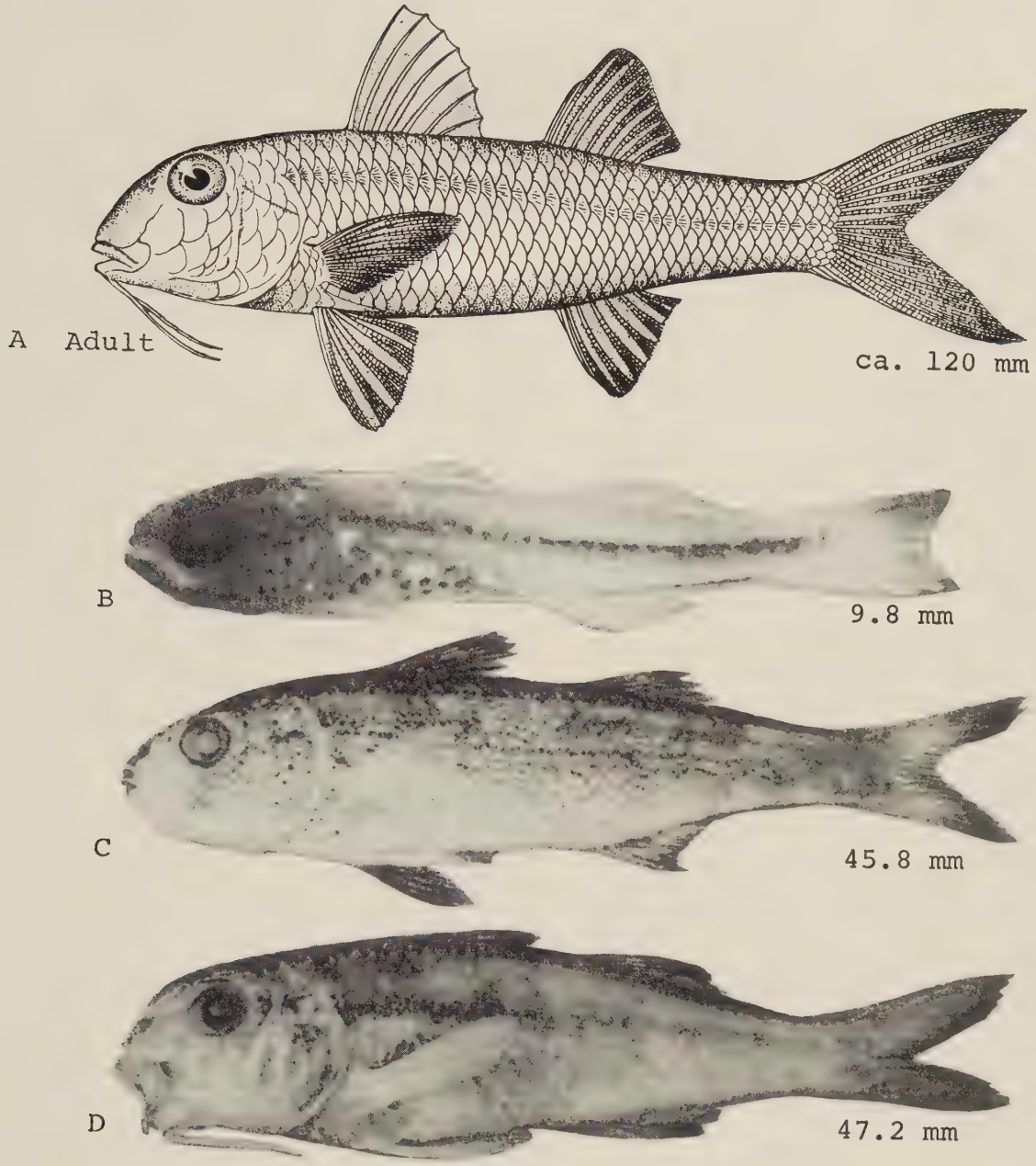

Fig. 148. *Mullus auratus,* Red goatfish. A. Adult, ca. 120 mm. B. Pelagic juvenile, 9.8 mm. C. Pelagic juvenile, 45.8 mm. D. Metamorphosed juvenile, 47.2 mm. (*A, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 360. B-D, Caldwell, M. C., 1962: figs. 25–26.*)

complete. At 14 mm no pelvic fin rays segmented; at 14.5 mm all rays segmented; at 18.7 mm no rays branched; at 25 mm branching complete. Scales extremely deciduous in pelagic juveniles; at 25.5 mm no ctenii on scales; at 45 mm 10 ctenii; at 117 mm 65 ctenii; at 199 mm 186 ctenii. At 8.2 mm both barbels still attached to branchiostegal membrane; at 14.5–24.5 mm at least one barbel free; at 28 mm bases of barbels shifted forward past posterior edge of mouth and anterior ends of bases coalesced. Below 50 mm teeth visible in upper jaw; at 12 mm teeth apparent; at 21 mm 3–4 teeth on each side; at 37 mm about 15 teeth on each side; at 45 mm many teeth evident, but upper lip beginning to grow over them; no teeth evident externally in specimens larger than 47 mm, even when lip is turned back. Teeth evident on lower jaw at 21 mm; at 37 mm several small canine teeth posteriorly in single row. At 10.9 mm a single palato-vomerine bone patch on each side of median line of roof of mouth, but no teeth evident; at 17 mm bone patches separated by .1 mm with 2 or 3 teeth

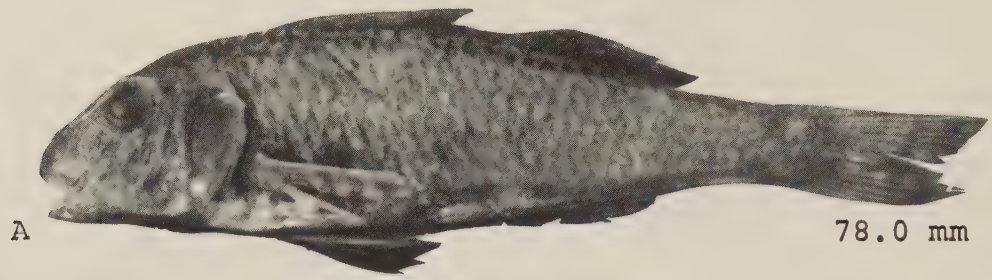

Fig. 149. *Mullus auratus,* Red goatfish. A. Metamorphosed juvenile, 78.0 mm. (*Caldwell, M. C., 1962: fig. 27.*)

on each. At 37 mm 15 coarse peg-like teeth on each patch; essentially like adult, but fewer teeth.[1]

Pigmentation: At 9.5–10 mm, in lateral view a series of elongate pigment patches along lateral midline beginning below end of first dorsal fin and extending to hypural; above lateral midline, surface covered with uniform light tan pigment; a line of darker pigment spots adjacent to second dorsal fin; below lateral midline several large dark spots surrounded by buff-colored areas between opercle and anal fin origin; area above anal fin clear except for some pigment just below lateral midline, and a row of dark chromatophores along ventral midline; in dorsal view a line of large pigment spots with tan radiations on each side of dorsal fins beginning behind head and extending back to procurrent caudal rays, forming a long, backward pointing, slender "V"; a well developed cluster of pigment spots over snout; in ventral view a row of large pigment spots along each side on ventral midline forming a similar "V"; just posterior to origin of anal fin, radiation from spots coalesces; all fins clear except caudal with a few scattered pigment spots on base. At 17.5 mm previously clear area now tan; a few pigment spots on dorsal fins and pigment spread midway onto caudal fin; at 23 mm more spreading of pigment in thoracic region; just below dorsal fins, a second row of pigment spots present; anal, pectoral, and pelvic fins still unpigmented; pigment on caudal fin about three-fourths length of principal rays. At 33.6 mm stripe on spinous dorsal fin two-thirds distance from base of fin to tips of spines; pigment spots midway between this stripe and base of fin beginning to form second stripe. At 45.8 mm second stripe on dorsal fin complete; a pigmented area on each ray of second dorsal fin just below a similarly pigmented area on preceding ray giving impression of a posteroventrally directed, oblique black stripe; similar stripe forming near base of fin on first 4 rays. At 47.2 mm metamorphosed to bottom living stage; uniform light tan background, lower half of body clear of chromatophores except for tiny scattered pigment spots; upper half with large pigment spots; scale margins with pigment; a third stripe on second dorsal fin. A 78 mm specimen in isopropyl and devoid of scales showed no pigment spots on body except for a few minute ones along dorsal surface; pigment spots grouped along principal caudal fin rays to form 4 bars in upper lobe and 5 in lower.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Pseudupeneus maculatus (Bloch), Spotted goatfish

ADULTS

D.VIII–I, 8; [1,2,3,9] A. II, 6; [1,3,9] C. 8+7,[1,3] procurrent rays 10+9–10; [3] P. 13–16; V. I, 5; lateral line scales 27 [1]–32; [10] vertebrae 10+14; [3] gill rakers 26–32 on first arch; branchiostegals 3.[1] Teeth in jaws uniserial, bluntly pointed, some of the enlarged anterior ones in the upper jaw curved variously sidewise and forward.[6] Vomer and palatines without teeth.[1,6]

Head 3.1 [10]–3.2,[6] depth 3.6–4 in SL; eye 3.6 [10]–5; snout 1.8 [6]–2.3,[10] maxillary 2.7 [9]–3.6, pectoral fin 1.4–1.6 [10] in head.

Body elongate, little compressed; anterior profile strongly arched,[6] more so in males, the females tending to be more fusiform with a less angulated profile; [1] caudal peduncle long and slender; snout very long; eye small, high and posterior; mouth small, maxillary not nearly reaching eye. Scales large, finely ctenoid,[6,10] completely covering head.[6] Lateral line continuous, with branched pores.[10] Dorsal fins completely separate, the first spine minute,[1,2] the remainder slender and flexible; [6] first ray of second dorsal and the second anal ray transitional spines (segmented distally, but not bilateral or branched); [1] caudal fin forked.[9] Throat with two long barbels (modified branchiostegals) reaching to preopercular margin or beyond.[6,9] Opercular spine present. Cleithrum with an enlarged, serrated wing-like process.[1]

Pigmentation: Color in life red above, merging into light yellow on sides, pale greenish below; bluish oblique streaks and bars on head; several longitudinal rows of light blue round spots, much smaller than pupil; 4 diffuse dark red blotches along lateral line, the first just under and partly on anterior end of lateral line, the second under the first dorsal fin, the third under the front of second dorsal fin, the fourth just behind second dorsal fin, sometimes an additional faint one on caudal peduncle; spinous dorsal fin light red near base, yellowish distally; soft dorsal fin pale bluish with light yellow on membrane and red on middle of rays; pectoral fins yellow with red on rays; pelvic fins pale blue with streaks of red and yellow on first rays; anal fin pale reddish; caudal fin pale blue, lower base yellow, upper red and yellow; barbels pink near base, yellow distally; lips and throat pinkish.[6] After 33 days in formalin lateral blotches black, only the 3 anteriormost evident.[1] Color changeable, blotches often lost while swimming, re-appearing upon settling to the bottom; [5] greenish in sea grass beds.[5,8]

Maximum size: Reported to reach 280 mm TL.[2]

DISTRIBUTION AND ECOLOGY

Range: New Jersey and Bermuda [4] to Santos, Brazil,[1] including the southern and northeastern Gulf of Mexico,[4] Central America, and the Bahamas.[5]

Area distribution: Atlantic and Ocean counties, New Jersey.[7]

Habitat and movements: Adults—occurring in shallow water,[8] in larger, deeper, sandy-bottomed tide pools and around the fringes of turtle grass beds (FDM), singly or in groups of 4 or 5, occasionally to as deep as 54 m; [8] abundant at depths of at least 45 m in Jamaica.[11]

Larvae—no information.

Juveniles—two stages, a pelagic one frequently taken at the surface over depths as great as 1830–3660 m and a shallow water, bottom living stage not known to occur deeper than 77 m; pelagic stage retained until fish either find shallow water or reach a size of about 60 mm; transformation may occur as early as 40 mm; [1] metamorphosed juveniles frequent sheltered areas around reefs, *Thalassia* beds and embayments, often with schools of juvenile grunts.[11]

SPAWNING

40 mm specimens taken from January to July suggesting a prolonged spawning period; [1] in the Caribbean main spawning period January–April with a subsidiary peak in October.[11]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Smallest examined 18.5 mm.

At 18.5 mm all but first dorsal soft ray segmented and only the last branched; at 29 mm 7 rays branched; at 37.4 mm all 8 soft rays branched; by 40 mm all dorsal soft rays segmented. At 18.5 mm 7 anal soft rays segmented, 2 branched; by 29 mm, all six rays

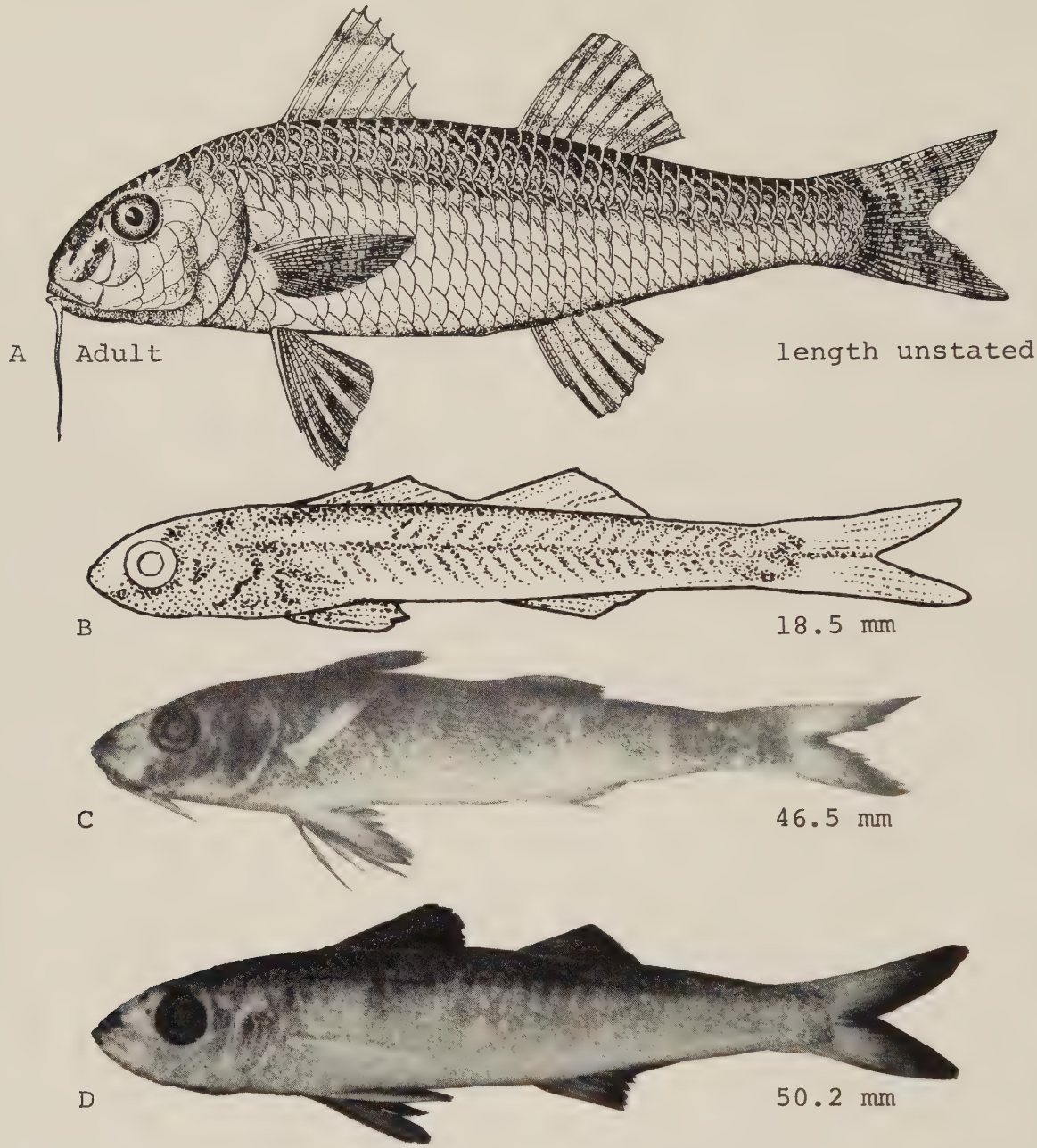

Fig. 150. *Pseudupeneus maculatus*, Spotted goatfish. A. Adult, length unstated. B. Pelagic juvenile, 18.5 mm. C. Pelagic juvenile, 46.5 mm. D. Pelagic juvenile, 50.2 mm. (*A, Jordan, D. S., and B. W. Evermann, 1896–1900: fig. 362. B-D, Caldwell, M. C., 1962: figs. 7, 4.*)

branched. At 18.5 mm 8+7 principal caudal fin rays, 9+10 procurrent rays; by 57.5 mm first 2 dorsal and ventral procurrent rays segmented, as in adult. At 21.6 mm no pectoral fin rays segmented or branched; at 29 mm fifth to eleventh ray segmented, fifth branched; at 34.1 mm second to eleventh ray segmented, fourth to eighth branched; at 50.2 mm second to fifteenth rays segmented, all but first 2 and last branched; by 103.4 mm all pectoral fin rays segmented and all but first 2 branched, as in adult. At 18.5 mm no pelvic fin rays branched; at 21.6 mm 2 pelvic fin rays branched; at 29 mm all 5 soft pelvic rays branched. By 29 mm both throat barbels well developed and free. Teeth evident by 21.6 mm; enlarged curved canines of upper jaw begin to appear in some by about 80 mm and are well developed in most by 130 mm. Above 50 mm, serrated wing of cleithrum very evident. Scales of pelagic juveniles quite deciduous, time of first appearance thus difficult to

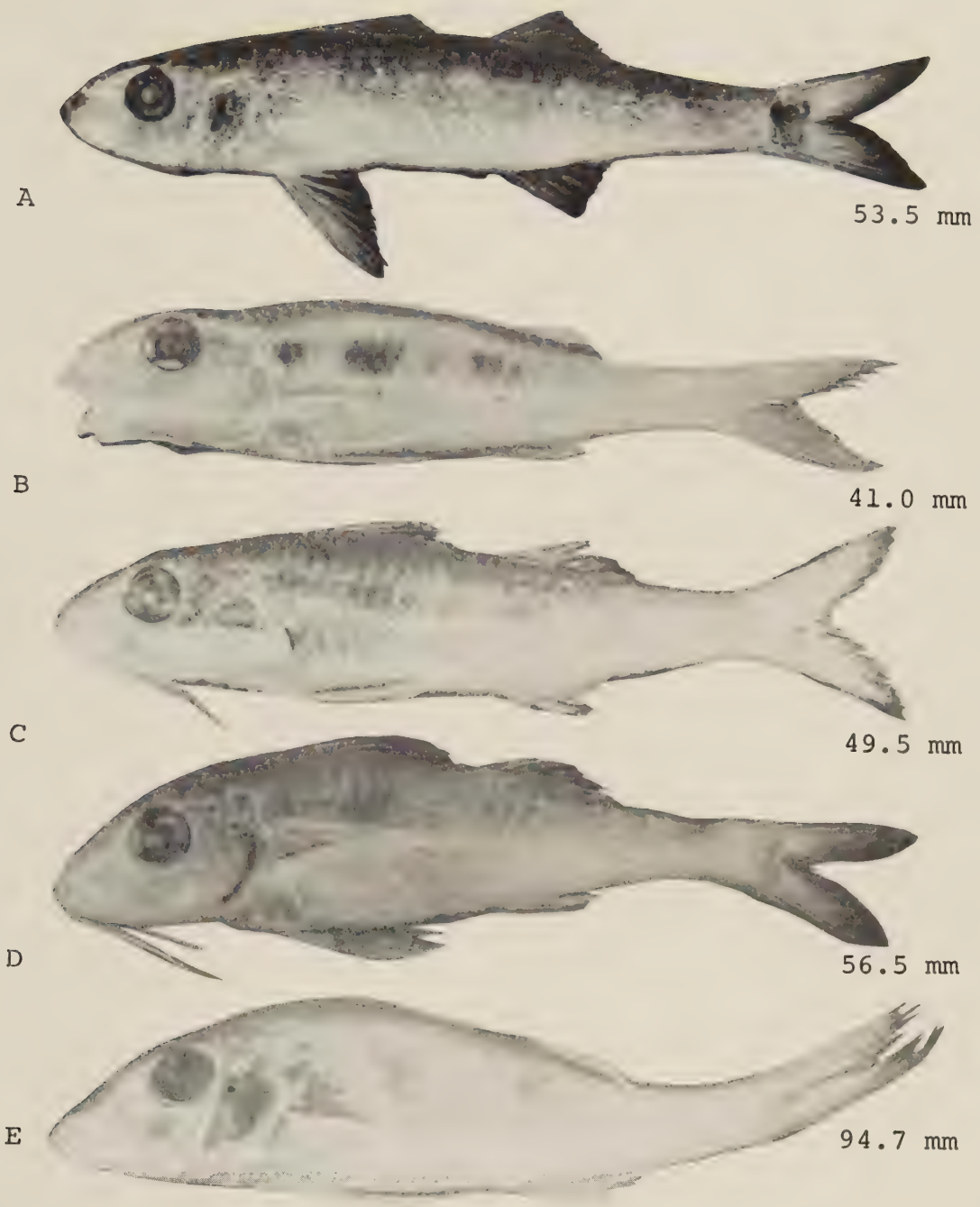

Fig. 151. *Pseudupeneus maculatus,* Spotted goatfish. A. Pelagic juvenile, 53.5 mm. B. Metamorphosed juvenile, 41.0 mm. C. Metamorphosed juvenile, 49.5 mm. D. Metamorphosed juvenile, 56.5 mm. E. Metamorphosed juvenile, 94.7 mm. (*A-D, Caldwell, M. C., 1962: figs. 4, 3, 5, 8.*)

determine; by 41 mm a full complement of lateral line scales present; at 30.1 mm scales without ctenii; at 42.4 mm 18 ctenii; at 50.2 mm 52 ctenii; at 189 mm 141 ctenii.[1]

Pigmentation: At 18.5 mm, body tan with a row of large closely spaced chromatophores along lateral midline from which thin fingers of pigment spread posterodorsally and anteroventrally just below dorsal fin, a second row of pigment spots parallel to lateral midline; above and below lateral midline streaked pigment spots form bars directed anteriorly toward midline at an oblique angle from caudal fin lobes, almost joining the midline to form several arrow points; in dorsal view, large dark pigment spots along each side of dorsal fins forming a "V" tapering to caudal fin, also heavy pigmentation over tip of snout and top of head; in ventral view, a "V" of chromatophores similar to dorsal one; fins clear except for an occasional pigment spot on caudal. At 29 mm oblique bars above lateral midline form a homogenous mottling, bars below still evident; caudal and dorsal fins with a few pigment spots, pelvic and anal fins clear. At 36.5 mm pigment in bars below lateral midline more diffuse; 2 clear wavy lines above and below lateral midline forming a heart shaped design. At 46.5 mm chromatophores between snout and supraoccipital bones coalesced; dorsal and caudal with pigment spots. At 50.2 mm pigment spots present on 2 dorsalmost pectoral fin rays. Degree of color metamorphosis in pelagic juveniles (40–75 mm) not dependent on size; in metamorphosing series, dark pigment of lateral midline replaced by lighter color; below lateral midline, a second light horizontal line present, apparently an extension of lower half of heart design. At 94.7 mm, 3 lateral blotches well developed; fins without pigment except for a single black patch on second dorsal; 2 light lines along lateral midline still evident.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

Estimated that males attain maturity at a length of about 200 mm FL and reach 222 mm FL at the subsequent spawning; females appear to mature at 175 mm FL and reach 187 mm FL by the following spawning.[11]

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Archosargus probatocephalus
Diplodus holbrooki
Lagodon rhomboides
Stenotomus chrysops

porgies
Sparidae

FAMILY SPARIDAE

The Sparidae includes over 100 species distributed worldwide in tropical and temperate inshore waters. There are approximately 22 species in the western Atlantic, four of which are known to occur in the Chesapeake Bay region.

Porgies are, for the most part, bottom oriented, omnivorous fishes, frequently feeding on hard-shelled invertebrates which they crush with their posterior molariform teeth. They are often said to resemble deep bodied snappers or grunts in general appearance, however, anatomically they are quite distinct. A primary distinction is in the composition of the maxillary sheath. Lutjanids, haemulids, and sparids all possess a maxillary which is sheathed beneath the circumorbital region for most of its length. In the Lutjanidae and Haemulidae the maxillary sheath is composed of only one bone, a very deep lacrimal, however, in the Sparidae, the second suborbital is as deep as the lacrimal and it is these two bones that comprise the sheath.

Some other significant characters of the Sparidae are as follows: lacrimal, snout, and preopercular flange without scales; distal end of premaxillary bifurcated to form a vertical groove which cradles the maxillary just anterior to its distal expansion; 6 branchiostegals; 10+14 vertebrae; principal caudal rays 9+8; procurrent spur absent; vomer and palatines without teeth; subocular shelf present on second suborbital; pelvic axillary process present; predorsal configuration 0/0+0/2+1/1/; a distinctive suspensorial configuration (GDJ).

Nearly all sparids produce pelagic eggs and show no parental care (Breder and Rosen, 1966). Although protandric hermaphroditism has been reported for a number of species, it has not been demonstrated in any New World species.

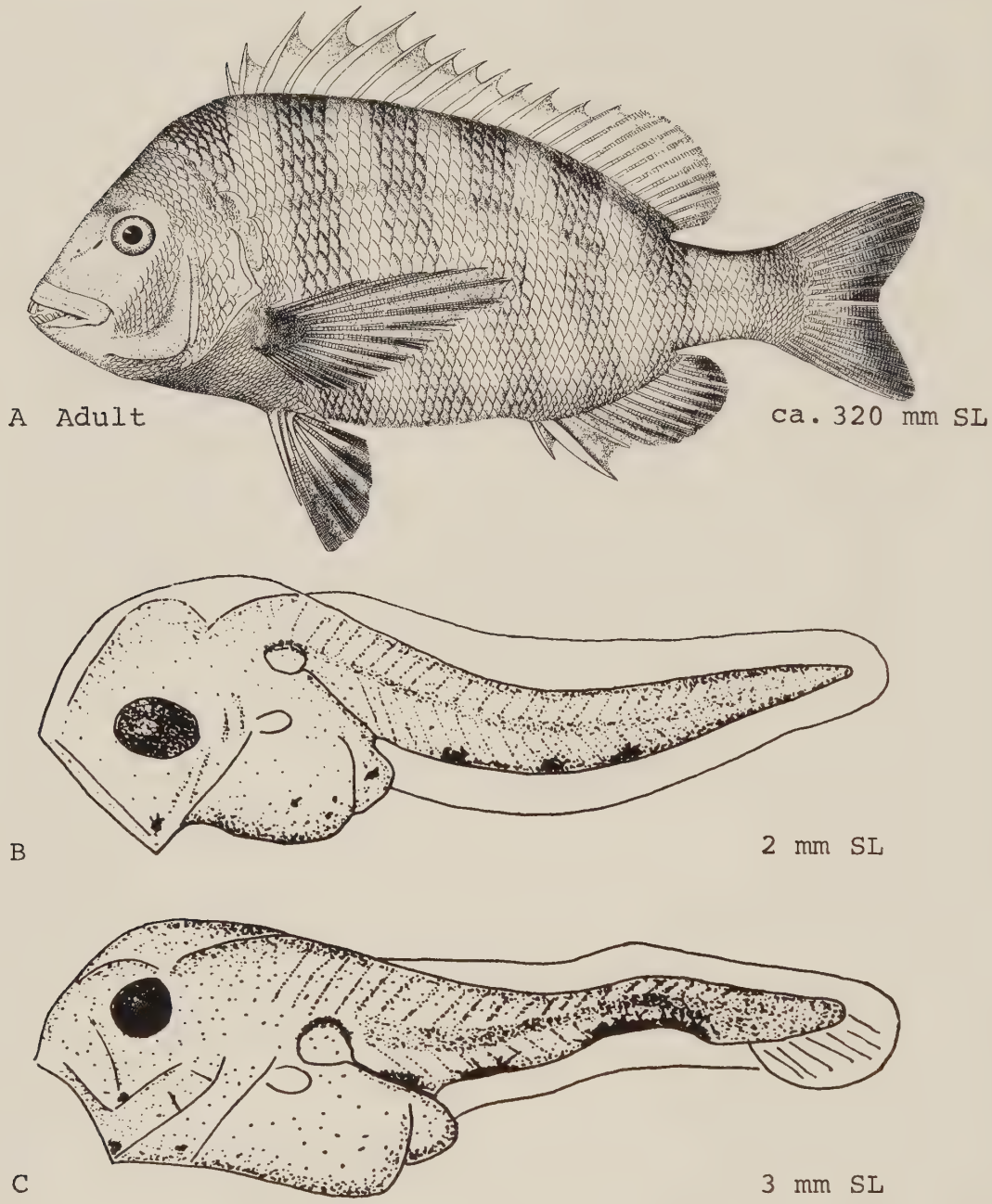

Fig. 152. *Archosargus probatocephalus*, Sheepshead. A. Adult, ca. 320 mm SL. B. Yolk-sac larva, 2 mm SL. C. Yolk-sac larva, 3 mm SL. (*A, Goode, G. B., 1884: pl. 131. B, C, Mook, D., 1977: fig. 1 A, B.) D. K. Caldwell, pers. comm., has pointed out some inaccuracy in the location of the crossbars in the adult illustration. The first complete bar should be located under the origin of the dorsal fin. Also there is always a bar under the end of the dorsal and one at the middle of the caudal peduncle. Fig. 156 shows the true bar placement.*

Archosargus probatocephalus (Walbaum), Sheepshead

ADULTS

D. X to XII, 10–13, typically XII, 11; [1] A. III, (9 [16]) 10–11; [5,8,10] C. 9+8, procurrent rays 8–9+7; [16] P. 15–17; [11] V. I, 5,[8] axillary process well developed; [18] scales 44 [8]–50 [10] in lateral series, lateral line scales 41–53; [1] vertebrae 10+14; [5] gill rakers short, 6 [8]–9 [1] on lower limb of first arch, branchiostegals 6 (GDJ); anterior teeth incisiform,[8] entire or slightly notched,[4] 3 above and 4 below; posterior teeth molariform, 3 series above and 2 below; [5] vomer and palatines without teeth.[10,18]

Head 3 [8]–3.3,[5] depth 1.9 [8]–2.5; [5] pectoral fin 2.5–3.7 in SL; snout 2.1–2.6, eye 2.7–4.5, maxillary 2.7–3.3 in head.[8]

Body stout, deep, moderately compressed; [8,10] back elevated, head short, deep, snout short; [8] mouth horizontal,[10] maxillary reaching about to anterior margin of eye, slipping under lacrimal for all or most of its length. Scales ctenoid. Dorsal fin continuous, with strong spines,[8] preceded by a procumbent spine; [5,8] caudal fin slightly forked; [8,10] pectoral fins long,[8] reaching beyond anal origin; pelvic fins not reaching anus.[5]

Pigmentation: Color greenish yellow,[8] sides with 6 black crossbars, not counting the incomplete head bar [1,8] (occasionally only 5 bars on one or both sides, this being the typical count in the Gulf of Mexico populations west of Alligator Harbor, Florida [1,11]); dorsal, anal, and pelvic fins mostly dusky or black, caudal and pectoral fins greenish.[8]

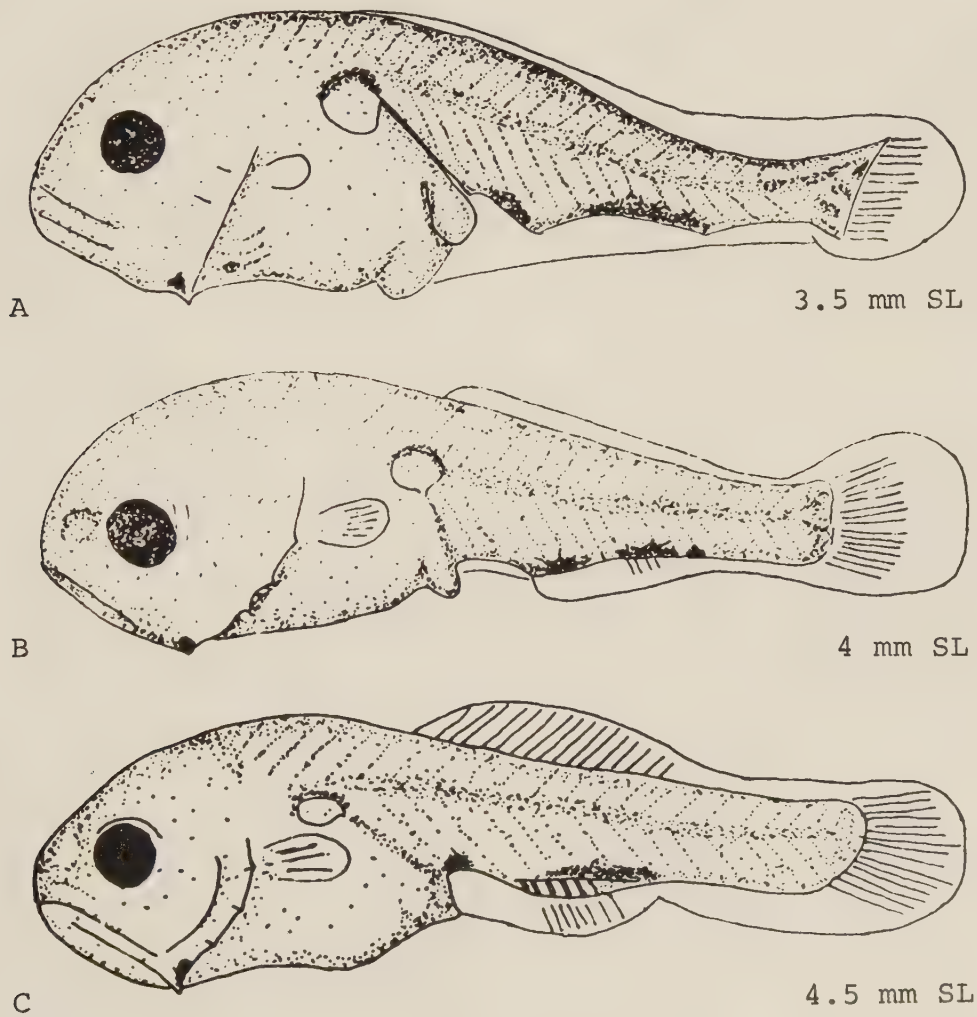

Fig. 153. *Archosargus probatocephalus*, Sheepshead. A. Yolk-sac larva, 3.5 mm SL. B. Yolk-sac larva, 4 mm SL. C. Larva, 4.5 mm SL. (*Mook, D., 1977: fig. 1 C-E.*)

Maximum size: Largest specimen recorded weighed 13.5 kg (length not reported).[8] Average weight .5–1 kg, length 280–380 mm, and individuals up to 2.3 kg and 500 mm are not rare.[4]

DISTRIBUTION AND ECOLOGY

Range: Atlantic and Gulf Coast from Cape Cod [8,9] to Rio de Janeiro; [1,3] a continental species, not occurring on any of the Caribbean islands (DKC).

Area distribution: Chesapeake Bay; at lower Potomac River, Cape Charles City, and Ocean View, Virginia; [8] Atlantic City, New Jersey.[14]

Habitat and movements: Adults—bottom loving, frequenting oyster beds and muddy shallow waters, particularly about inlets; [9] also frequents piers, breakwaters and wrecks; [4] often running far up rivers; does not typically school but commonly forms feeding aggregations. Occurs inshore from spring to fall in North Carolina; [10] probably present throughout the year in the Tampa Bay area.[7] Reported from salinities of .5 [12]–43.8 ppt and temperatures of 12.8–35.1 C.[2]

Larvae—pelagic, smallest (6 mm) taken at surface near sandy shore; later stages taken in shallow areas over grass beds.[4,7]

Juveniles—up to 50 mm inhabit grass beds [4,7] (*Ruppia* in North Carolina [4] and *Diplanthera* in Tampa Bay [7]) where they feed on the small soft-bodied forms associated with grass (possibly a result of their lack of crushing dentition); at about 50 mm, they leave grass beds and establish themselves in adult habitat around rocks, pilings, wrecks, and bulkheads where, with crushing dentition now well developed, mollusks and barnacles constitute a major part of their diet.[4,7]

SPAWNING

Reported to spawn in Florida on sandy beaches,[13] but more recent evidence indicates spawning probably occurs offshore [7] during the spring.[4,7,9]

EGGS

Buoyant; diameter about .8 mm, transparent.[13]

EGG DEVELOPMENT

Incubation period: 40 hours at 24–25 C.[13]

YOLK-SAC LARVAE

Up to about 4.5–5 mm.

Dorsal fin with about 16 actinotrichia at 4.5 mm. Anal fin with a few actinotrichia at about 4 mm; by 4.5 mm some lepidotrichia beginning to form. Caudal fin apparent as a series of actinotrichia in posteroventral part

Fig. 154. *Archosargus probatocephalus*, Sheepshead. A. Larva, ca. 6 mm. B. Larva, ca. 7.5 mm. (*Hildebrand, S. F., and L. E. Cable, 1938: figs. 18–19.*)

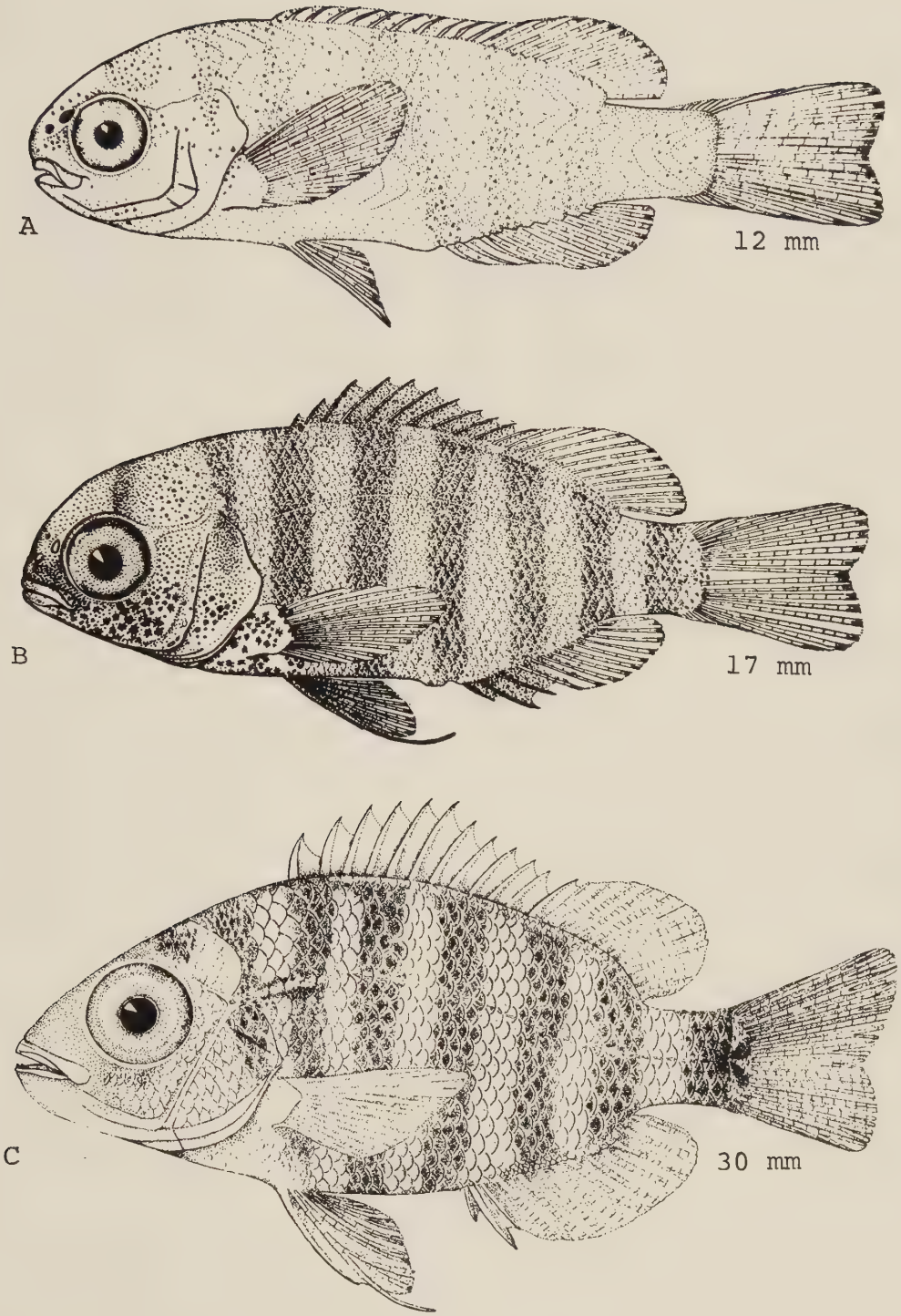

Fig. 155. *Archosargus probatocephalus*, Sheepshead. A. Larva, 12 mm. B. Larva, 17 mm. C. Juvenile, 30 mm. (*A-C, Hildebrand, S. F., and L. E. Cable, 1938: figs. 20–22.*)

Fig. 156. *Archosargus probatocephalus,* Sheepshead. A. Juvenile, ca. 160 mm SL. (*Goode, G. B., 1884: pl. 130.*)

of finfold at 3 mm; lepidotrichia evident by 3.5 mm; caudal fin well developed by 4 mm. Pectoral fin buds present at 2 mm, with actinotrichia by 4 mm, and lepidotrichia by 4.5 mm.[17]

Pigmentation: One small melanophore present at angle of jaws and 3 along ventral side of body posterior to anus; some with 1 or 2 small melanophores on yolk sac.[17]

LARVAE

Approximately 5 mm [17]–25 mm.[4]

Dorsal fin with 7 spines and 12 soft rays at 6 mm; 12 spines present by 12 mm, but shorter than soft rays.[4] Anal fin with full complement of spines and soft rays by 6 mm. Pectoral fin rays well developed by 8 mm. Pelvic fin bud apparent at 6.5 mm; soft rays well developed by 8 mm; [17] fin large by 18 mm with second ray produced as a filament to anal origin, but outer ray not fully developed as spine. Body covered with scales by 12 mm. Myomeres about 27 at 6 mm. Lateral line appears anteriorly at 10–12 mm, fully developed by 15–18 mm.[4]

At 6 mm body depth 3.4, head 3.0 in SL; snout 4.2, eye 3.1 in head. Maxillary reaching about to pupil at 6–12 mm, slightly past anterior margin of eye at 15–18 mm; preopercle with a few feeble spines at 6 mm, absent by 15–18 mm. Notochord flexed by 6 mm.[4] Oil globule lost by 7 mm.[17]

Pigmentation: At 6 mm body brownish, median ventral line with 3 obscure dark spots, one behind isthmus, another below vertical from base of pectoral fins, the third just in front of anus; 2 dark specks on base of anal fin. At 7.5 mm 3 dark spots still present; scattered chromatophores forming a suggestion of adult crossbars posteriorly.[4] At 8 mm the posterior four bars distinguishable. By 11 mm all 7 crossbars (including head bar) evident.[17] At 18 [4]–25 mm characteristic adult coloration developed.[17]

JUVENILES

25–30 mm and larger.

At 25–30 mm dorsal and anal spines proportionately as long as in adult. Caudal fin slightly forked at 25–30 mm. Pelvic spine fully developed by 25–30 mm, filament of second ray becoming shorter; by 75 mm no longer than other rays.[4]

At 25–30 mm body depth 2.3–2.5, head 2.8–2.9 in SL; snout 4.1, eye 3.0 in head. Eye undergoes considerable reduction in size with growth: at 50–60 mm 2.8–3.3 in head; at 75 mm 3.2; at 100 mm 3.5; at 225 mm 4.5.[4]

Pigmentation: Color in life of an individual approximately 67 mm in length: Body with 5–6 broad shining black crossbands separated by silvery spaces; dorsal dusky, membrane of spinous portion with black edge; anal fin black; pectoral fins white; pelvic fins blue-black; tail

white; a round black humeral spot, larger than pupil, partly in second crossband and partly in first interspace, on level with upper half of eye.[10]

GROWTH

Fairly slow rate of growth. At Beaufort, N.C. in June largest 20–25 mm, July largest 11–42 mm (average 21.8 mm), August smallest 27 mm, September smallest 38 mm.[4] In Tampa Bay area average in June 20.7 mm, in July 29 mm, in August 41.5 mm.[7]

AGE AND SIZE AT MATURITY

No information.

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Diplodus holbrooki (Bean), Spottail pinfish

ADULTS

D. XII [2,3,7] to XIII, 13–16; [7] A. III, 13 [2,3,7]–15; C. 9+8, procurrent rays 8–9+8; [13] P. 15–17; [7] V. I, 5; [3,9,10] scales 55–57 in lateral series,[3] lateral line scales 50–61,[7] 4 scale rows on cheek; [10] vertebrae 10+14 [2,13] (11+14 [13]); gill rakers short, 14 on lower limb,[3] 17–21 total; [2] branchiostegals 6; [10] anterior teeth incisiform, 4 above and 4 below; posterior teeth molariform, 3 series above and 2 below; [2,3] vomer and palatines without teeth.[10]

Head 3.7, depth 2.1, pectoral fin 3.3 in SL; [2] eye 4.3 [3]–4.5,[2] maxillary 3.3 in head.[3]

Body regularly elliptical, moderately compressed; [2,3] eye small; mouth large, almost horizontal; [2] maxillary failing to reach eye, slipping under lacrimal along most of its length.[3,10] Dorsal fin continuous, rather low, longest spine less than half the head,[3] not preceded by a procumbent spine; [2,10] caudal fin deeply forked; [2,3] pectoral fins pointed, reaching origin of anal; [3] axillary process of pelvic fin well developed.[9,10] Swim bladder present.[10]

Pigmentation: Color dull blue above, lower part of sides silvery; a conspicuous black, saddle-like blotch on anterior part of caudal peduncle; opercular margin black; base of pectoral fins black.[3]

Maximum size: 355 mm.[3]

DISTRIBUTION AND ECOLOGY

Range: Common along the Atlantic coast south of Beaufort, North Carolina,[10] through the Florida Keys [8] to the Tortugas [5] and into the Gulf of Mexico as far west as Port Aransas, Texas; [12] a few specimens known from Chesapeake Bay.[6,7]

Area distribution: Chesapeake Bay at Cape Charles City, Virginia.[6]

Habitat and movements: Adults—prefer open waters of high salinity to depths of at least 27 m, occurring only rarely in brackish water and probably never in fresh water; [1] frequent piers and breakwaters in North Carolina; [3] small schools often found along rocky shore at Tortugas; [5] in shallow waters prefer vegetated bottom; move to deeper waters in fall and winter.[1] Reported from salinities of 9.7 [4]–31.0 ppt (one record from 1.8 ppt [1]) and temperatures of 15.5 [4]–32.5 C.[1]

Larvae—no information.

Juveniles—at Cedar Key, Florida, individuals under 90 mm most abundant on shallow, inshore flats in spring and summer, moving to deeper water in fall and winter; individuals 91 mm and larger taken primarily offshore near reefs (depth approximately 4.5 m), also moving to deeper water in fall and winter.[1] Juveniles reported to pass through stage between 26–40 mm during which they clean ectoparasites from other fish.[11]

SPAWNING

In Florida occurs offshore in late December, January, or February, probably not lasting more than two months.[1]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

Body with 5 narrow, vertical, dark stripes on back and sides, with an equal number of short intermediate stripes on back.[3]

GROWTH

Most rapid during early summer months, with little or no growth during winter; reach about 60 mm in the first 6 months of growth.[1]

AGE AND SIZE AT MATURITY

At 90 mm, gonads developed but not mature; [4] probably first spawn in second year at about 130 mm.[1]

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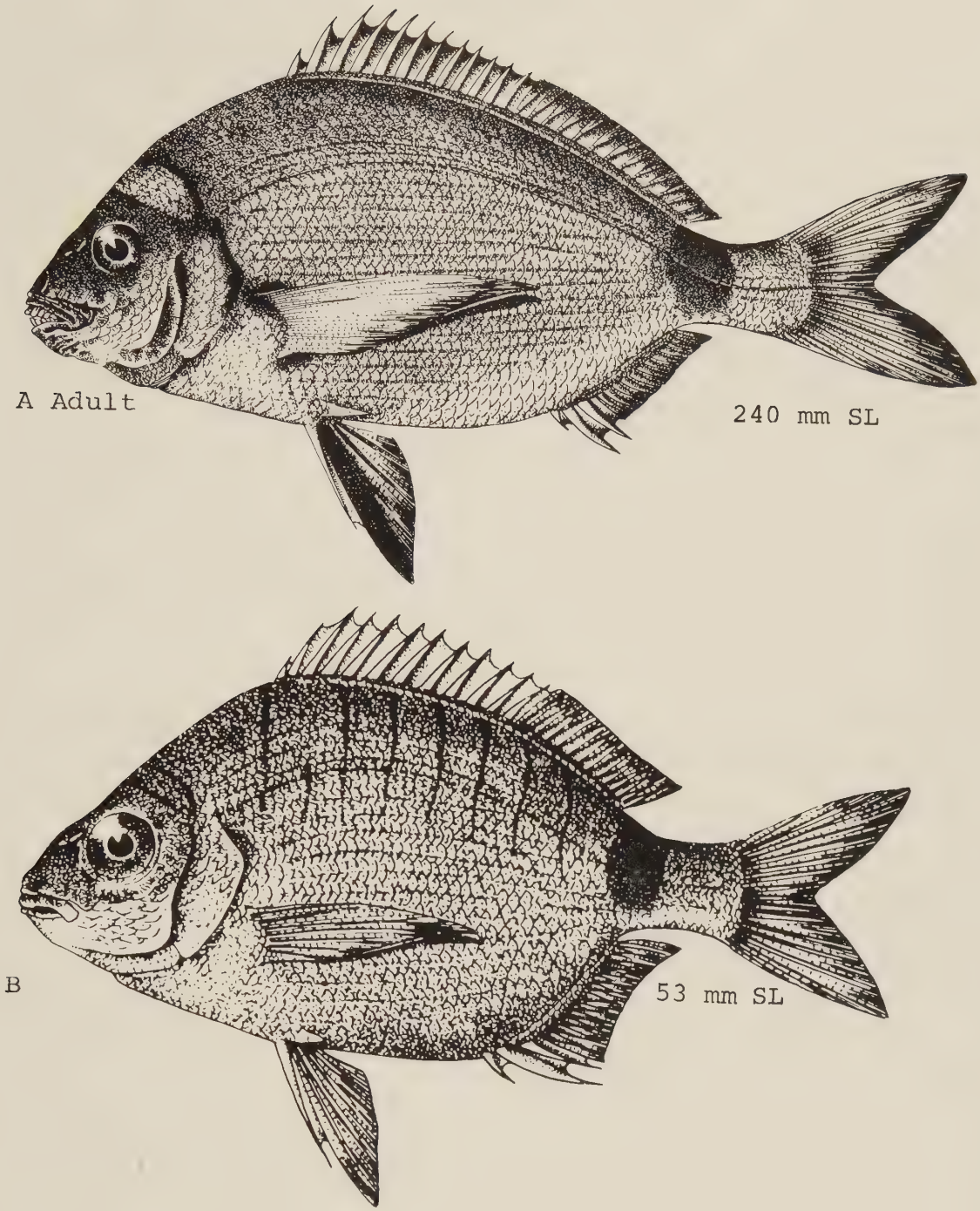

Fig. 157. *Diplodus holbrooki,* Spottail pinfish. A. Adult, 240 mm SL. B. Juvenile, 53 mm SL. (*Paz, R. de la, 1975: figs. 35–36.*)

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Lagodon rhomboides (Linnaeus), Pinfish

ADULTS

D. XI to XIII, 10–12, usually XII, 11 (rare spine counts below XI likely due to damaged specimens); A. III to IV 10–12, usually III, 11; C. 9+8, procurrent rays 10–11+7–10; P. 14–17, usually 16; V. I, 5; lateral line scales 53–68, 10 scales between lateral line and dorsal fin, 17–19 scales between lateral line and anal fin;[1] vertebrae 10+14;[9,21] gill rakers 6–9+10–15, usually 7+13;[1] branchiostegals 6 (GDJ); a single row of 8 incisiform teeth in each jaw, the anterior ones with a single notch, the posterior ones with or without a notch; several rows of rounded molariform teeth behind these;[1] vomer and palatines without teeth (GDJ).

Head 3.1–3.4, depth 2.1–2.3, pectoral fin 2.9–3.5 in SL; eye 2.7–3.1, snout 3.2–4.1, maxillary 2.9–3.3 in head.

Body oblong, compressed, back elevated; head moderate; snout pointed; mouth small, nearly horizontal, terminal;[8] maxillary slipping under lacrimal along most of its length.[3] Scales small, ctenoid, forming a sheath on dorsal and anal fin bases. Dorsal fin continuous, rather low, spines slender and sharply pointed, preceded by an antrorse spine; caudal fin forked; pectoral fins long, pointed, reaching well beyond tips of pelvics;[8] pelvic fin with well developed axillary process.[16]

Pigmentation: Color in life olivaceous with bluish silvery sides, 4–6 variably distinct dark vertical bars and a dark humeral spot;[7,8] several light blue and yellow longitudinal stripes (fading in alcohol);[8] dorsal fin pale bluish with a submedian gilt band and a gilt edging[7] or with faint yellowish brown spots;[8] caudal fin yellow, faintly barred; anal fin bluish with a medium yellow band;[7] pelvics plain with a yellowish streak along middle of fin.[8] Tone of various life colors variable with habitat.[1]

DISTRIBUTION AND ECOLOGY

Range: Cape Cod, Massachusetts and Bermuda to Yucatan, including entire Gulf of Mexico;[1] also recorded from the Bahamas;[14] doubtful records from Cuba[13] and Jamaica.[12]

Area distribution: Lower Chesapeake Bay; Cape Charles, lower York River, Buckroe Beach, Ocean View, Lynnhaven Roads, Virginia;[8] Delaware River estuary;[10] Atlantic City and Peermont, New Jersey.[18]

Habitat and movements: Adults—prefer open waters as opposed to estuaries;[1,19] vegetation most important factor in habitat choice;[1,3,4] where vegetation not available seek other shelter in form of rocks, pilings, etc., but no apparent bottom preference (taken on mud, coral, sand, rock, and mixtures); usually free swimming but may bury themselves completely in bottom when under stress;[1] essentially nonschooling, but occasional aggregations have been reported offshore, possibly for spawning;[6] found in waters from a few centimeters to 73 m, older year classes generally occurring in deeper water;[1] large specimens taken in shallow water in winter and late fall;[15] begin to arrive on grass flats in Florida in late November and early December, population density reaching a maximum by late June; remain over grass flats where they live in the spring until they migrate out of the estuary in late summer and fall; most appear to move very little in summer; at start of spawning migration into Gulf of Mexico, form schools of same age.[20] Wide salinity and temperature tolerance, recorded from 0–44.5 ppt and 7–37.9 C,[11] but rare above 32 C.[17]

Larvae—pelagic, youngest taken offshore near surface;[1,2] arrive in inshore waters from December to May at about 11 mm, where they are found on open and protected beaches and unprotected and protected shallow flats.[1]

Juveniles—abundant on shallow flats early, moving to deeper flats and channel edges with growth,[1] some apparently remaining entire first year in shallow water.[3]

SPAWNING

Location: Occurs offshore, probably near surface;[1,2,6,17,20] location probably more a function of depth (or temperature) than distance offshore.[1]

Season: In Florida, occurs in late fall and early winter, probably mid-October through March with a December–January peak;[1] also occurs in late fall and winter in Texas,[17] North Carolina,[2] and probably throughout range.[1]

Fecundity: A 157 mm female taken at Vero Beach, Florida in late November contained an estimated 90,000 eggs.[1]

EGGS

Ripe unfertilized eggs 0.99–1.05 mm, mean of 1.02 mm.[5]

EGG DEVELOPMENT

At 18±2.5 C and 34±2.2 ppt:

3 hours—three-quarters reached early blastula.
6 hours—expanded blastula becoming evident.
16 hours—late gastrulation occurred and embryonic axis evident.
23 hours—optic cups and lens present; oil droplet attached to the embryo.
27 hours—heart beating, body movement established.

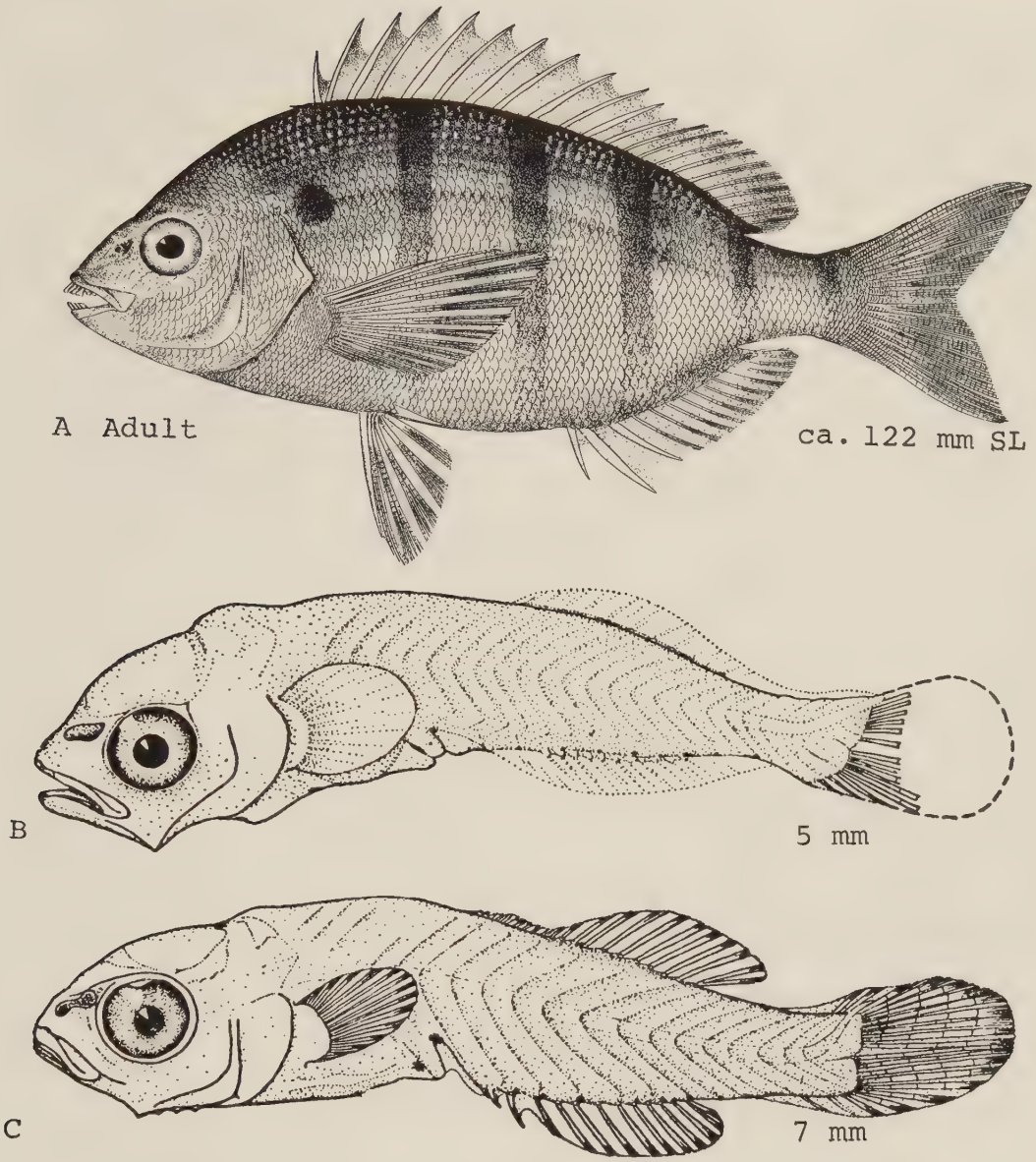

Fig. 158. *Lagodon rhomboides*, Pinfish. A. Adult, ca. 122 mm SL. B. Larva, 5 mm. C. Larva, 7 mm. (*A, Goode, G. B., 1884: pl. 138. B, C, Hildebrand, S. F., and L. E. Cable, 1938: figs. 12–13.*)

48 hours—most eggs hatched.

Hatching did not occur where more than one oil droplet was present.[5]

YOLK-SAC LARVAE

At 18±2.5 C 50% utilization of the oil droplet occurred 17 hours after hatching.[5]

LARVAE

Less than 5 mm to 15–20 mm.

At 5–6 mm rays begin to appear in soft dorsal and anal fins; at 6–7 mm 12 rays visible; by 8–10 mm spines differentiated. At 5–6 mm rays begin to appear in caudal fin; at 8–10 mm caudal rounded; at 12 mm caudal square; by 14 mm caudal concave. At 5 mm pectoral fin well devel-

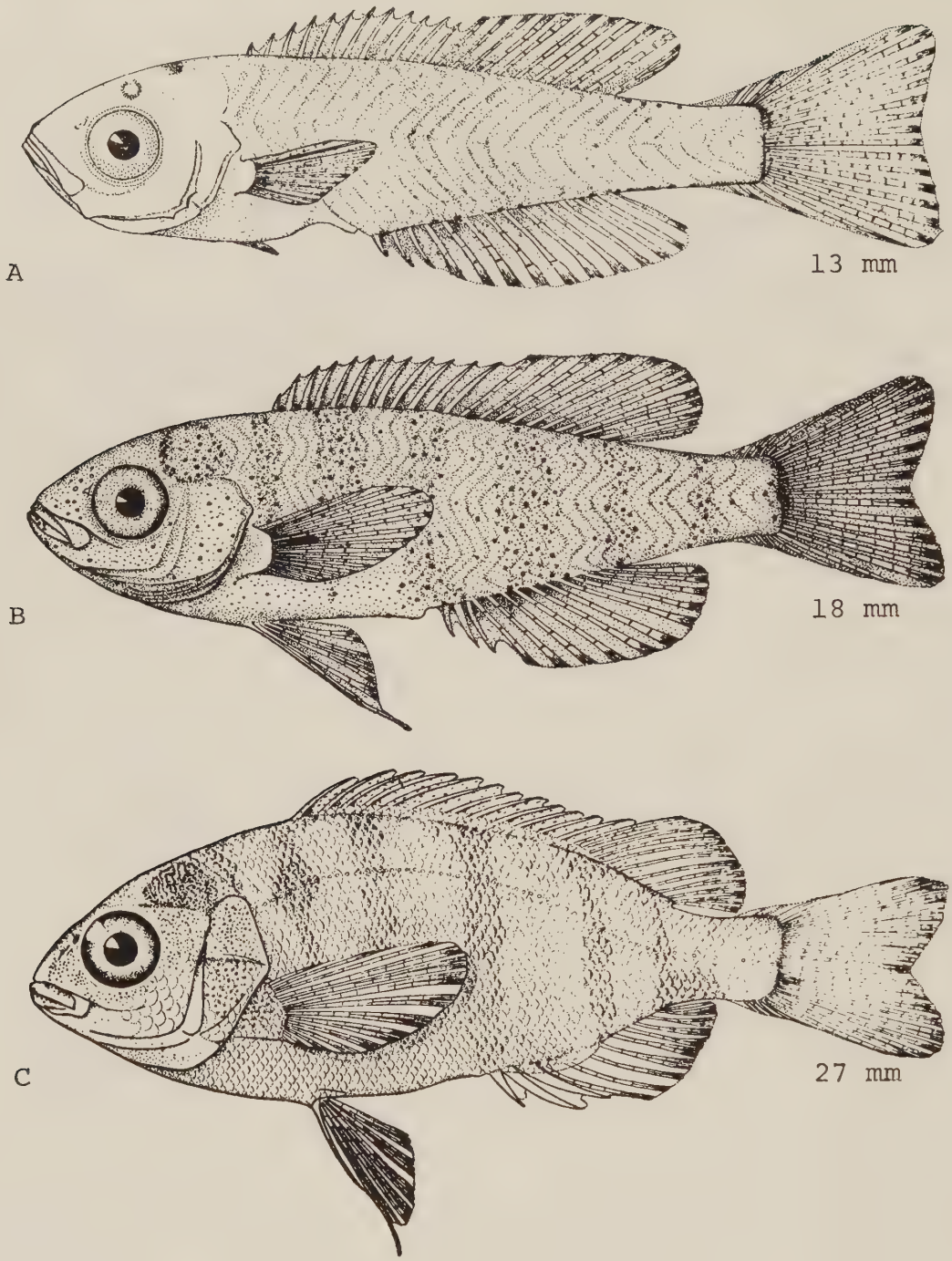

Fig. 159. *Lagodon rhomboides*, Pinfish. A. Larva, 13 mm. B. Juvenile, 18 mm. C. Juvenile, 27 mm. (*A-C, Hildebrand, S. F., and L. E. Cable, 1938: figs. 14–16.*)

oped; by 8–10 mm extends to anus. At 8–10 mm pelvic fins minute; at 15 mm nearly as long as eye; by 18 mm spines differentiated. At 5 mm total myomeres about 20. Teeth present by 10 mm; [2] at 14 mm a series of long, sharp, conical teeth present.[1] Scales first form at about 15 mm. Notochord flexed by 5 mm.[2]

Pigmentation: At 5 mm pale with 3 dark spots, one near isthmus, one on chest, and one just in advance of anus; a row of ventral spots from anal origin to base of caudal. At 6–7 mm several spots on base of caudal fin, one at nape, and an elongate blackish one above base of pectoral fin.[2]

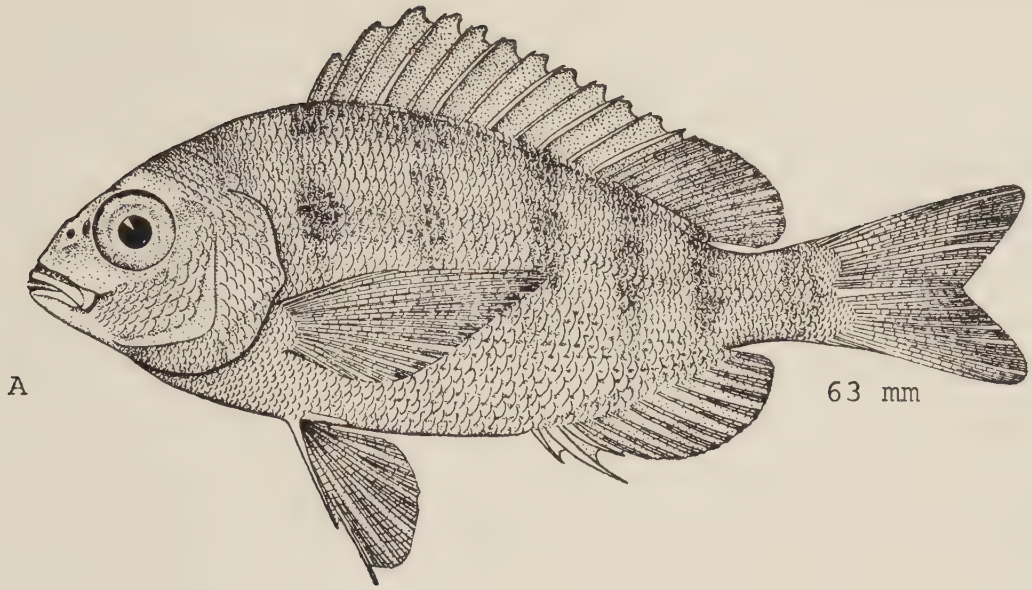

Fig. 160. *Lagodon rhomboides*, Pinfish. A. Juvenile, 63 mm. (*Hildebrand, S. F., and L. E. Cable, 1938: fig. 17.*)

JUVENILES

15–20 mm [2] to around 100 mm or more.[20]

Caudal fin becomes more deeply forked with growth. Pectoral increases to beyond anus after 40 mm. From 20 to 100 mm first pelvic soft ray produced as a filament, reduced in larger specimens.[2] At 16–20 mm notched incisiform teeth appear outside the conical row of teeth and gradually replace them; by 20 mm, this is complete, with 8 incisors in each jaw, each bearing 3 notches formed by 2 large hooked outer horns and 2 short inner peaks; at 27–59 mm the horns and peaks become shorter and flattened, until the 2 lateral notches are obscured, leaving 1 central notch bordered by a flat area on either side.[1]

Pigmentation: At 16–17 mm lemon yellow to orange chromatophores over most of body, concentrated in area where black melanophores are least dense; a black humeral spot present, dorsal and anal fin membranes tipped with a brick red which spreads to base of fin; eye iridescent bluish; red chromatophores appear as definite bars on sides, the yellow showing no particular pattern.[1] At 30 mm color pattern essentially as in adult.[2]

GROWTH

As computed from changes in length between consecutive trawling periods in Florida: Daily increase in length averaged .19 mm for 0 age group and .12 mm for yearlings; growth of both age groups slowed as season progressed from spring to winter, the daily increase of the 0 age group averaging .32 mm in the spring, .23 mm in the summer, and .01 mm in the fall, and of yearlings .32 mm in the spring, .21 mm in the summer, .04 mm in the fall and .02 mm in the winter. As computed from scale measurements: Annual increase in length of yearlings averaged .14 mm per day; seasonal increase in length of yearlings averaged .12 mm per day in the spring, .14 mm per day in the summer, .20 mm per day in the fall, and .09 mm per day in the winter. First scale annulus formed in April of second year.[20] By end of first summer reach 70–75 mm; by end of first year reach 65–110 mm; growth rate slows after first year, the mean increase in the second year being only 55 mm, and that in the third year being only 45 mm.[1]

AGE AND SIZE AT MATURITY

Smallest with developing gonads taken in one Florida study 128 mm, thought to be in third year,[1] however other more recent evidence from Florida population indicates that all yearlings spawn and even some 0 age group individuals may spawn; gonad maturation probably takes place during spawning migration or near offshore spawning sites.[20]

Probably mature somewhere between 80–110 mm.[20]

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Stenotomus chrysops (Linnaeus), Scup

ADULTS

D. XII, 12; A. III, 11–12; [8,9,10] C. 9+8, procurrent rays 9–10+8–10; V. I, 5; scales in lateral series 49 [10]–54; vertebrae 10+14; [14,16] gill rakers short, 9 on lower limb of first arch; branchiostegals 6 (GDJ); anterior teeth narrow, conical, not notched; laterally 2 more or less definite rows of molariform teeth.[10]

Head 2.9–3.4, depth 1.9–2.4, pectoral fin 2.8 in SL; eye 2.5–3.9, snout 2.3–2.5, maxillary 2.8–3.2, caudal peduncle 2.5–3.6 in head.[10]

Body rather deep, compressed; back elevated, reaching highest point under anterior dorsal spines;[10] head bluntly pointed, compressed, profile slightly concave above eye; mouth small, terminal, angle well in advance of eye.[9,10] Scales finely ctenoid; top of head, snout, and orbital naked, rest of body scaly.[10] Dorsal fin continuous, spinous portion notably longer than soft portion; dorsal fin not preceded by a procumbent spine; caudal fin forked; [9,10] pectoral fins reaching to origin of soft dorsal; [8] pelvic fin with well developed axillary process.[14]

Pigmentation: Color in life dull silvery and iridescent, darker above; sides and back with 12–15 indistinct longitudinal stripes flecked with light blue streak at base of dorsal fin, head silvery with irregular dusky blotches; belly white; dorsal, anal, and caudal fins flecked with blue; pectoral fins brownish; pelvic fins white and bluish,[8] axil usually with a dusky spot.[10]

Maximum size: Reported to reach about 450 mm.[8,9]

DISTRIBUTION AND ECOLOGY

Range: East coast of North America from Nova Scotia to eastern Florida,[3] infrequent north of Cape Cod.[9] (Some authors recognize the populations south of Cape Hatteras as a separate species, *S. aculeatus,* GDJ.)

Area distribution: Southern Chesapeake Bay, Maryland; Cape Charles City, lower York River, Ocean View, Lynnhaven Roads, Virginia; [10] Delaware Bay; [2] Atlantic City, Cape May, Barnegat Inlet, Bradley Beach, New Jersey.[12]

Habitat and movements: Adults—prefer smooth to rocky bottoms, usually schooling, in summer at depths between 1.8 and 36 m; [8] northern populations migrate south and offshore for the winter (from New York and New England to New Jersey and North Carolina) and back in the spring; [5,8] leave coast in late October and November, occasionally as late as December,[1,8] winter off Virginia and North Carolina from 36–91 m (sometimes to 164 m) and off New England from 82–128 m; [8] most abundant off New York and New Jersey in fall from 30–70 m to as deep as 170 m; [13] taken at mouth of Chesapeake Bay from early April, farther north from early May.[8] Sensitive to lower temperatures, probably preferring water at least as warm as 7 C, most abundant off New York and New Jersey at 13–16 C.[13]

Larvae—no information.

Juveniles—no information.

SPAWNING

Location: No evidence that spawning occurs as far south as Chesapeake Bay,[8] occurring farther north in relatively shallow water.[6]

Season: In late spring [10] and summer,[1,4,6,7,8] in Long Island Sound.[6]

Temperature: At bottom temperatures of 10–18 C and surface temperatures of 13–23 C.[6]

EGGS

Pelagic; spherical and transparent,[7] .85–1.15 mm in diameter; [6] membrane thin and horny; [7] one oil globule located at upper pole,[7] .1–.2 mm in diameter.[6]

EGG DEVELOPMENT

Similar to that described for *Tautoga onitis* by Kuntz and Radcliffe [7] (see Volume 5 for a description of that species); pigmentation first observed in embryos with 15–20 myomeres as black and yellow spots scattered sparsely over embryo and oil globule; as time of hatching approaches, yellow chromatophores become aggregated to form heavily pigmented areas.[10]

Incubation period: 40 hours at 22 C.[7]

YOLK-SAC LARVAE

Hatch at about 2 mm.

Anus a short distance from posterior margin of yolk sac, but less than half length of body from anterior end; head projects slightly beyond anterior end of yolk sac and is not appreciably deflected; oil globule remains in posterior end of yolk sac.[7]

Pigmentation: At hatching, a small group of black chromatophores sparsely scattered over dorsal and dorsolateral aspects of body; small areas of yellow pigment on dorsal and lateral aspects of head, above vent, opposite vent dorsally, and a transverse band approximately halfway from vent to posterior end of body extending from

base of pelvic finfold onto dorsal finfold; black and yellow chromatophores scattered over oil globule.[7]

LARVAE

Specimens described 2.8–25 mm.

At 10 mm dorsal, anal and caudal fins becoming well differentiated; at 25 mm body plump, but back not highly arched, depth shallow.[7]

Pigmentation: At 2.8–3 mm (3 days after hatching) yellow pigment greatly reduced and transverse band absent; small yellow areas remaining just back of eye, at poste-

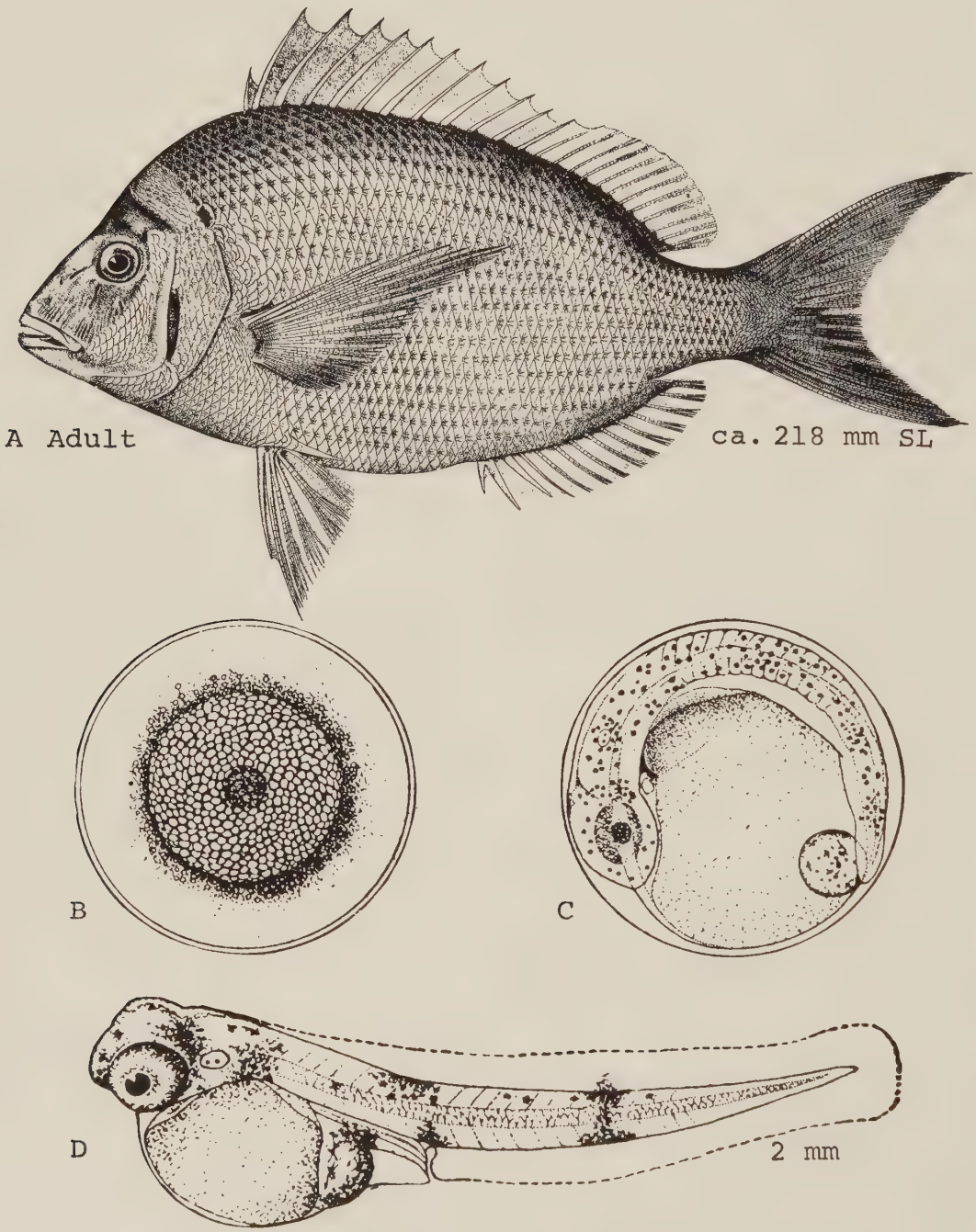

Fig. 161. *Stenotomus chrysops,* Scup. A. Adult, ca. 218 mm SL. B. Egg with blastoderm in advanced stage of cleavage, periblast differentiated. C. Egg showing advanced embryo. D. Yolk-sac larva several hours after hatching, 2 mm. (*A, Goode, G. B., 1884: pl. 133. B-D, Kuntz, A., and L. Radcliffe, 1918: figs. 30–32.*)

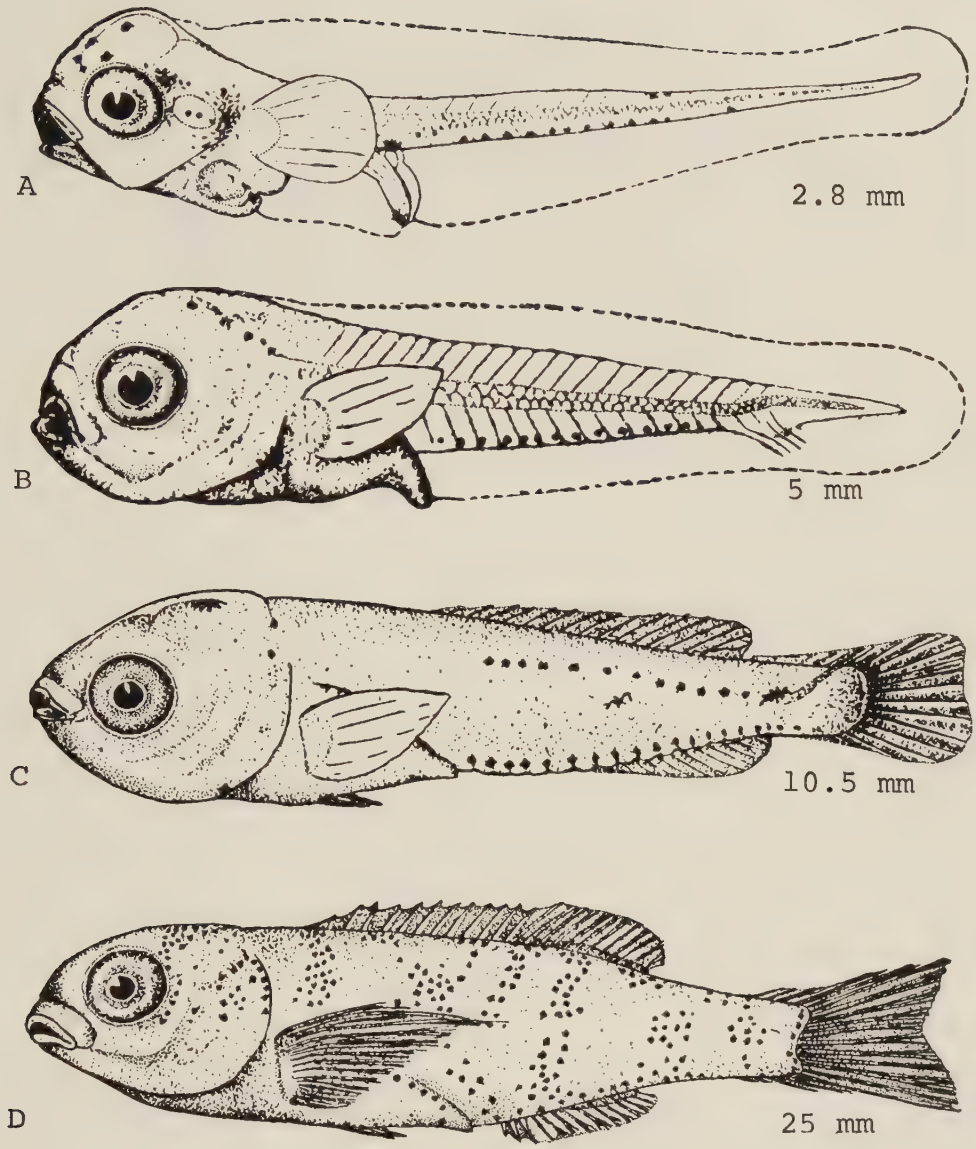

Fig. 162. *Stenotomus chrysops,* Scup. A. Larva 3 days after hatching, 2.8 mm. B. Larva, 5 mm. C. Larva, 10.5 mm. D. Larva, 25 mm. (*A-D, Kuntz, A., and L. Radcliffe, 1918: figs. 33–36.*)

rior margin of opercle, over vent, and diffusely scattered over anterior region of body; small areas of black pigment on dorsal aspect of head and lateral aspect of anterior region of body; a black spot on anterior portion of anus and a series of black spots along base of anal finfold. At 5 mm little yellow pigment remaining; black spot at vent absent, but characteristic series of black spots near base of ventral finfold more prominent. At 10 mm increased pigmentation in dorsal region of abdominal cavity; series of black spots on ventrolateral aspect still present; an additional series of black spots apparent along lateral line over posterior half of body. At 25 mm ground color brownish yellow; black chromatophores more numerous and arranged in irregular transverse bands.[7]

JUVENILES*

23 mm and larger.

Fin rays proportionately shorter than in adults.[10]

Pigmentation: Color when freshly preserved very pale or light brown; muzzle, except tip of snout, opaque creamy white, conspicuously contrasted with rest of head. Iris

*The 25 mm specimen illustrated by Kuntz and Radcliffe[7] does not have fully developed pelvic fins, however a 23 mm specimen described and illustrated by Fowler has all fins well developed and is obviously a juvenile (*GDJ*). This size discrepancy has not been resolved, however it is suggested that this might be the result of a misprint, the specimens of Kuntz and Radcliffe being only 15 mm (*DKC*).

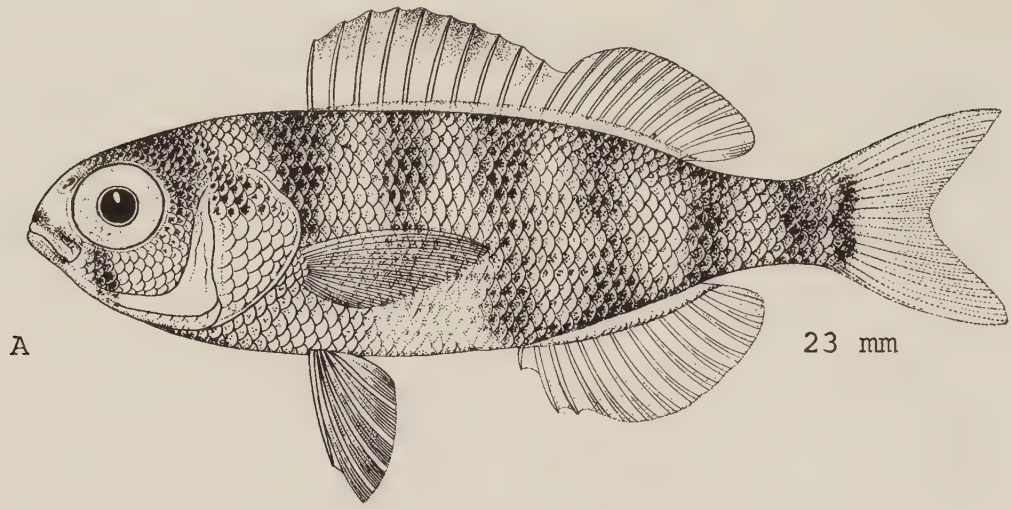

Fig. 163. *Stenotomus chrysops*, Scup. A. Juvenile, 23 mm. (*Fowler, H. W., 1944: p. 3.*)

and most of opercle silvery white; silvery white peritoneum shows through thin lower walls of abdomen; patch of dull brown composed of spots on each cheek scale; 7 transverse dark bars on head and body; caudal with transverse dark basal band; dorsals grayish distally, other fins all pale to whitish.[15]

GROWTH

Average 110 mm after 1 year, 160 mm after 2 years, 200 mm after 3 years, 230 mm after 4 years, and 250 mm after 5 years.[8]

AGE AT MATURITY

2 years.[4,11]

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Kyphosus incisor
Kyphosus sectatrix

sea chubs
Kyphosidae

FAMILY KYPHOSIDAE

The Kyphosidae includes about 10 to 12 nominal species in three genera occurring in tropical and subtropical inshore waters throughout the world. Two species, both in the genus *Kyphosus*, occur in the western Atlantic and these are occasionally taken in the Chesapeake Bay region. The species level systematics of the family is in need of revision, so the actual number of species is uncertain. Sea chubs are shallow water schooling fishes commonly found in rocky or reef habitats. They are apparently primarily herbivorous, but small crabs and mollusks are sometimes found in their stomachs.

Kyphosids are somewhat oval in general body shape with the soft dorsal and anal completely sheathed in scales. The mouth is small and the jaws bear small, incisiform teeth. Other significant characters of the Kyphosidae are as follows: Typical predorsal configuration 0/0/0+2/1/; pelvic fin I, 5; pelvic axillary process present; teeth present on vomer and endopterygoids, present or absent on palatines; branchiostegals 7; subocular shelf absent; supramaxillary absent; vertebrae 10+15 or 16 (usually 16); principal caudal rays 9+8; caudal with two uroneurals and three epurals; procurrent spur present. This family has often been combined with the Girellidae and sometimes with the Scorpididae, however the available anatomical evidence does not support this (GDJ).

Very little is known of the reproductive habits of this family. Larvae and early juveniles are apparently pelagic, the latter being most frequently taken in floating *Sargassum*.

Kyphosus incisor (Cuvier), Yellow chub

ADULTS

D. IX to XII,[1] 13–15 (usually XI, 14 [1,3]); A. III, 12–13 (usually 13 [1,3]); C. 9+8 principal, procurrent rays 10+9; [1] P. 18–20 (usually 19 [1,3]); V. I, 5, scales 63–73 in row above lateral line,[1] lateral line scales 54–62; [3] vertebrae 10+16; [7] gill rakers long,[5] 5–9+17–23 on first arch; branchiostegals 7; [1,5] teeth as in *K. sectatrix*.[1]

Proportions in percent SL based on 5 specimens greater than 150 mm SL: Head 25.7–28.1; depth 39.8–41.0; eye 6.9–8.4; pectoral fin 16.9–18.2.[1]

Body and head shape similar to that of *K. sectatrix;* mouth small, horizontal, maxillary concealed under lacrimal along most of its length.[3] Dorsal spines depressible in a groove of scales; scales ctenoid,[5] covering all of head except tip of snout [3] and all fins except spinous dorsal; scales of back much smaller than those of sides. Axillary process of pelvic well developed; caudal fin lunate.

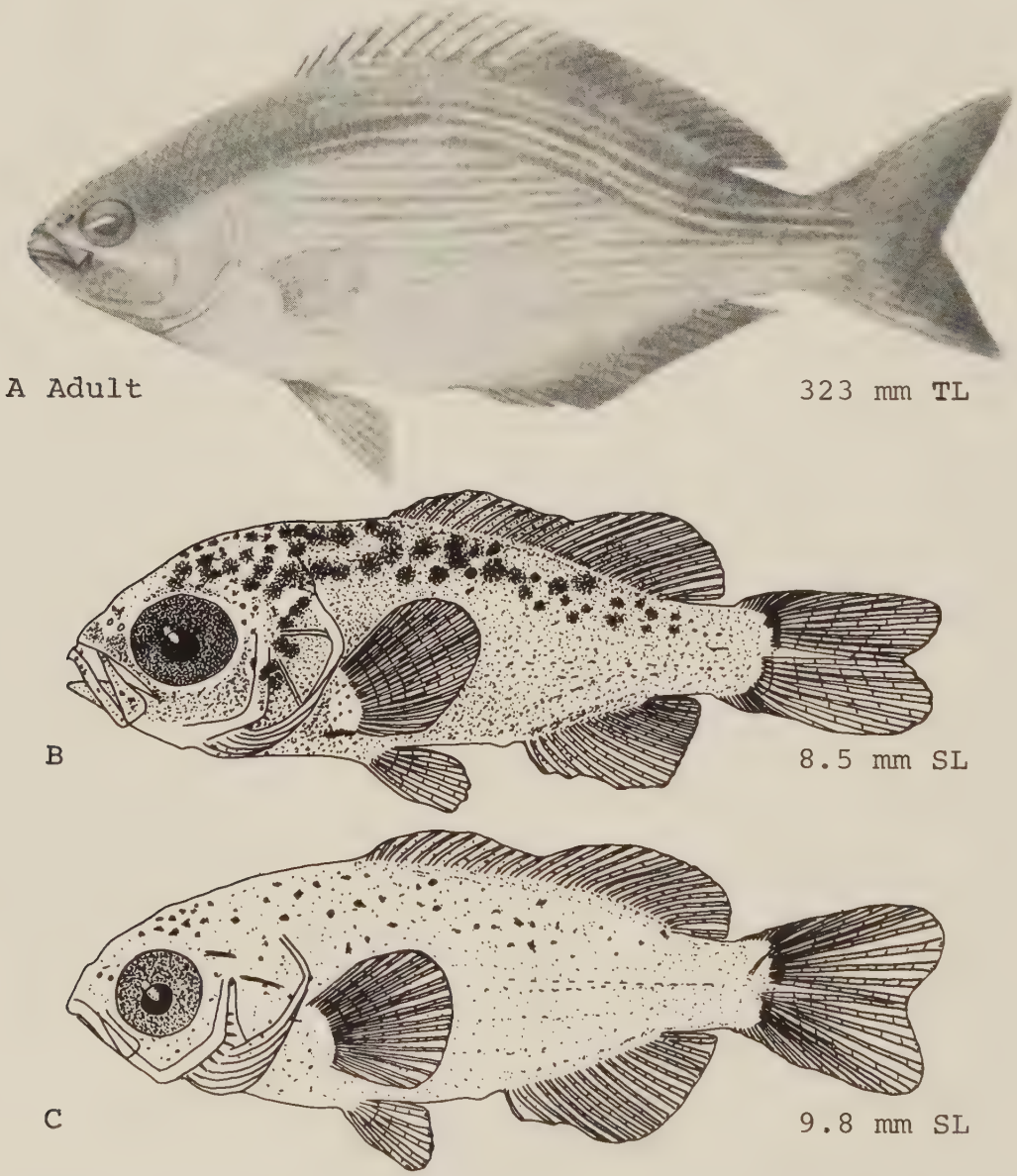

Fig. 164. *Kyphosus incisor,* Yellow chub. A. Adult, 323 mm TL. B. Juvenile, 8.5 mm SL. C. Juvenile, 9.8 mm SL. *(A, Böhlke, J. E., and C. C. G. Chaplin, 1968: 409. © Academy of Natural Sciences of Philadelphia. Used with permission of authors and publishers. B-C, Moore, D., 1962: figs. 6–7.)*

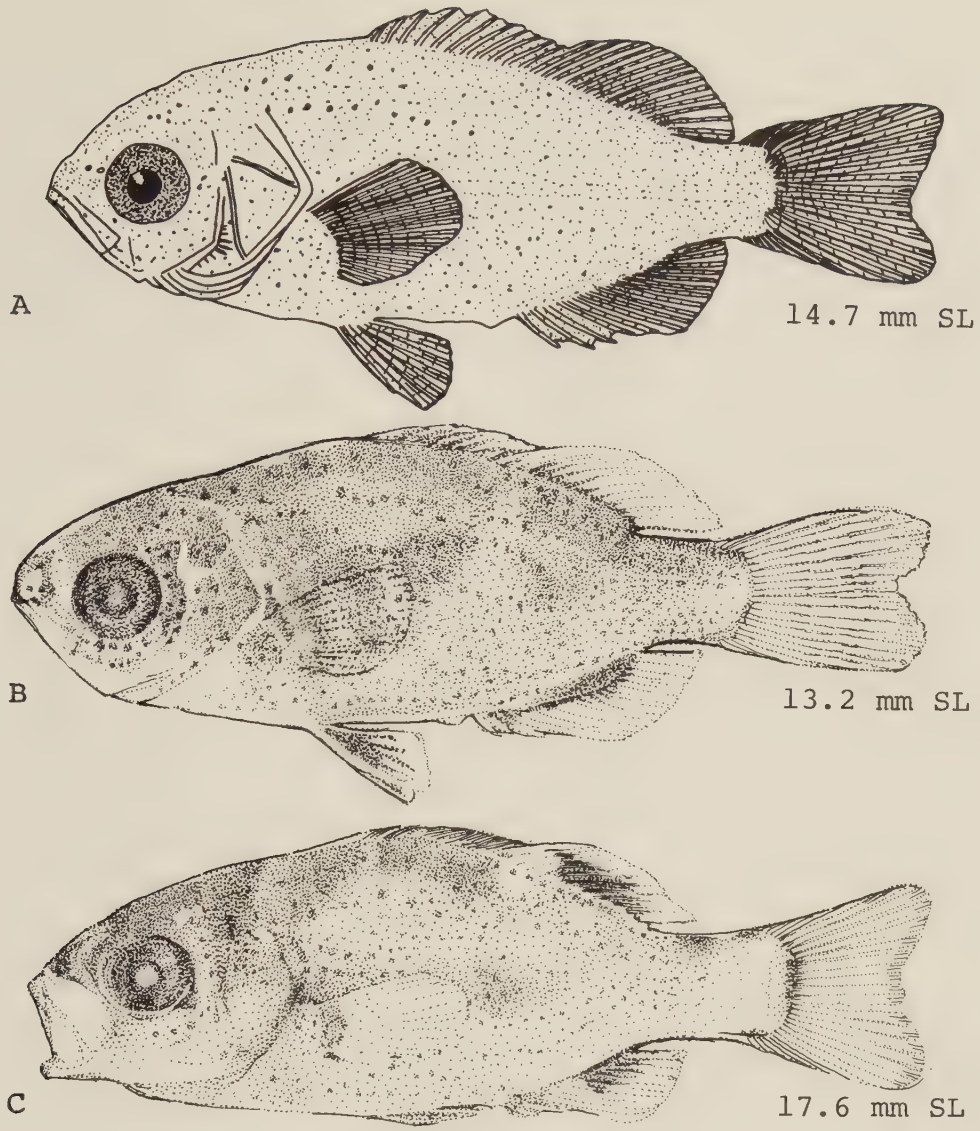

Fig. 165. *Kyphosus incisor,* Yellow chub. A. Juvenile, 14.7 mm SL. B. Juvenile, 13.2 mm SL. C. Juvenile, 17.6 mm SL. (*A, Moore, D., 1962: fig. 8. B-C, Moore, D., 1962: fig. 9 A-B, delineated by Joan Ellis.*)

Preopercle scarcely serrate.[5]

Pigmentation: Color in life similar to *K. sectatrix,* the yellow stripes on body and bands on head brighter and the opercular membrane not as dark; [3] pectoral yellow basally.[4,5] Color in alcohol uniform brassy on sides with buff-tan on underside; fins uniform buff; dark and light bands along scale rows evident.[1]

Maximum size: 673 mm; [3] reported to reach over 900 mm.[4,5]

DISTRIBUTION AND ECOLOGY

Range: Essentially the same as *K. sectatrix,*[3,4] but apparently not extending into Gulf of Mexico (GDJ); except for one spent female (358 mm) from Chesapeake Bay, only juveniles taken north of Bahamas.[1]

Area distribution: Chesapeake Bay at Kiptopeke, Virginia; [2] offshore Delaware and New Jersey.[1]

Habitat and movements: Adults—occur in schools near shore around rocky and reef areas.[4]

Larvae—no information.

Juveniles—taken most often under floating patches of *Sargassum,* often with *K. sectatrix;* northern records probably result of northward drift in Gulf Stream. Taken at salinities between 27.8 and 36.5 ppt and temperatures between 23.9 and 28.9 C.[1]

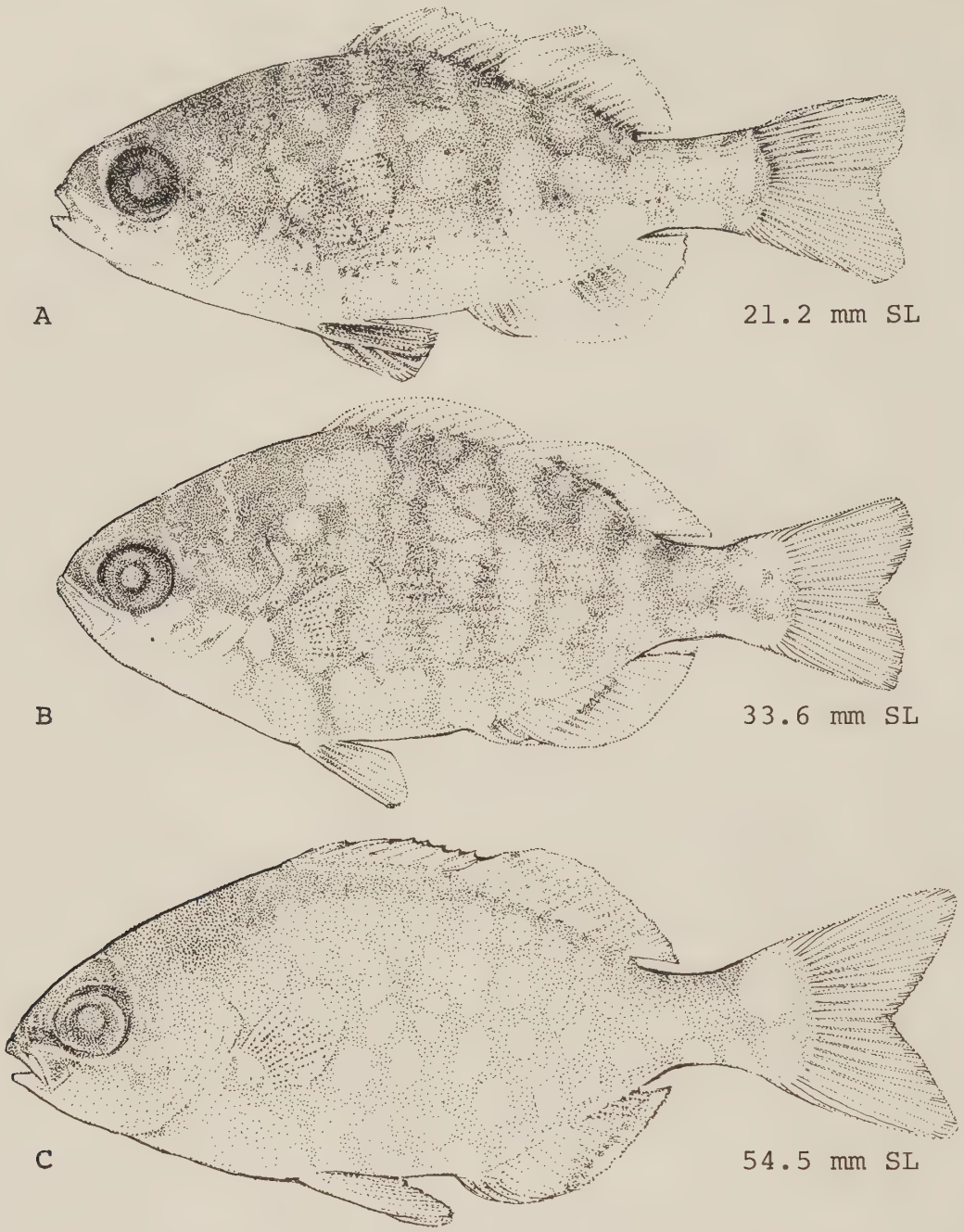

Fig. 166. *Kyphosus incisor*, Yellow chub. A. Juvenile, 21.2 mm SL. B. Juvenile, 33.6 mm SL. C. Juvenile, 54.5 mm SL. (*A-C, Moore, D., 1962: fig. 9 C-E, delineated by Joan Ellis.*)

SPAWNING

Occurs throughout much of year; probably greatest during spring and summer.[1]

EGGS

Ovarian eggs .07–.12 mm in diameter from spent female taken at Chesapeake Bay.[2]

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

8.5 mm or less and larger.

At 8.5 mm all dorsal soft rays segmented and unbranched; at 17.2 mm penultimate ray branched; at 17.5 mm all but first 2 and posterior element of last soft ray branched; at 19.0 mm all but first soft ray branched; at 25.8 mm all soft rays branched. At 8.5–17.2 mm all anal soft rays segmented and unbranched; at 17.5 mm all but first 2 and posterior element of last soft ray branched; at 19 mm all but first soft ray branched; by 21.7 mm all soft rays branched. At 10 mm all principal caudal rays formed, 9+8 procurrent rays; at 13.2 mm middle principal rays begin to branch; at 14.7 mm middle 12 principal rays branched; at 15.8 mm 10+8 procurrent rays; at 16.1 mm branching complete; at 28.4 mm 10+9 procurrent rays. At 10 mm second to thirteenth pectoral rays segmented; at 15.8 mm all but first and last segmented and all unbranched; at 28.4 mm all rays segmented and all but first 2 and the last branched; by 58 mm all but first 2 rays branched. At 8.5–9.8 mm all soft pelvic rays segmented and unbranched; at 10 mm middle rays branched; at 13.5 mm all soft rays branched. At 8.5 mm sides covered with scales from pectoral base to caudal peduncle and from just above lateral line to ventral edge of pectoral base, with same proportionate width back to peduncle; from 10–252 mm scale development similar to *K. sectatrix*. Gill raker number increases slightly from 10–50 mm, with no further increase. At 10 mm premaxillary with 10 caniniform teeth and dentary with 4; at 28.4 mm half of premaxillary teeth incisiform, dentary with 11–12 caniniform teeth, other teeth appear behind jaw teeth, vomer with 12 villiform teeth, pterygoids with 2 villiform teeth, and tongue with 2 patches of 6 villiform teeth each; by 100 mm teeth as in adults.[1]

Pigmentation: At 8.5 mm body with blotches of brownish-gray pigment with a background of large blackish spots and small spots on scales; pigment extends to middle of pelvics and over most of dorsal and anal fins except area of first 3 soft rays; pectoral fins with dark spots and stripes; larger spots on body stellate and concentrated above lateral line; a line of black dashes along middle of side posteriorly. At 11–13 mm gray pigment more uniform, pigment on dorsal, anal, and pelvic fins darker than on other parts; caudal and pectoral fins with little or no pigment. At 15 mm some specimens with pigment covering more than half soft dorsal and anal fins, light and dark streaks along scale rows with pattern varying from light patches on dark background to a uniform slate gray. At 21.2 mm pigment extends across entire base of caudal. At 22–30 mm a fine stippling of dark spots over most of caudal, pectoral, and last 2 or 3 dorsal and anal rays. At 33.6 mm stippling of fins more dense; a darker band of pigment with black spots appearing along outer row of scales on dorsal, anal, and caudal fins. At 54.5 mm black band more distinct; dark spots on sides absent.[1]

GROWTH

Juveniles may grow as slowly as 10 mm/month.[1]

AGE AND SIZE AT MATURITY

A spent female taken in Chesapeake Bay measured 358 mm SL and weighed 1.6 kg.[2]

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A Adult
195 mm TL
B
10.5 mm
C
15.0 mm
D
18.7 mm

Kyphosus sectatrix (Linnaeus), Bermuda chub

ADULTS

D. X [1] or XI, 11–13 (usually XI, 12 [1,7]); A. III,[1,7] 10 [7]–12 (usually III, 11 [1,7]); C. 9+8 principal, procurrent rays 9+9; [1] P. 17–19 (usually 18 [1,7]); V. I, 5; scales 60–73 in row above lateral line; [1] lateral line scales 51–58; [7] vertebrae 10+16; [11] gill rakers long,[9] 5–8+16–19 on first arch; [1] branchiostegals 7; [1,10] 13–22 incisiform teeth in a row on each jaw with large horizontal basal processes [1] not much longer than the vertical,[9,10] a band of villiform teeth behind incisors; [1,7] vomer, palatines, pterygoids and tongue with teeth.[1]

Proportions in percent SL based on 18 specimens greater than 150 mm SL: Head 25.5–33.9; depth 39.6–47.7; eye 7.5–12.0; pectoral fin 17.3–21.9.[1]

Body ovate, somewhat compressed; head short, snout blunt; [10] mouth small, horizontal, maxillary concealed under lacrimal along most of its length. Scales ctenoid, covering all of head except tip of snout, and all fins except spinous dorsal.[7] Spinous dorsal fin higher than soft dorsal, the longest spine one-fifth body depth; [9,10] dorsal spine depressible in a groove of scales; [10] longest anal ray 2.2 in head; [9,10] axillary process of pelvic well developed; [10] caudal fin moderately forked,[7] the lower lobe longer. Preopercle weakly serrate.[9,10]

Pigmentation: Color in life bluish gray [6] to dark gray; [7] edges of scales on back brassy, forming faint yellowish longitudinal stripes [6,9] which alternate with bluish ones of equal [9] or slightly greater width; [8] a yellowish stripe on head below eye, from maxillary to preopercular margin; [6,7,8,9] a white line across nape, yellow spot behind eye, and pelvic and anal fins blackish,[6,9] basal half of pectoral variously silvery,[8] fins otherwise grayish; [6,9] color somewhat changeable, lighter in open water.[8]

Maximum size: Usually reported to reach a length of 460 mm or more; [10] one specimen from Puerto Rico 760 mm.[7]

DISTRIBUTION AND ECOLOGY

Range: Atlantic coast of the United States from Woods Hole, Massachusetts south to the Dry Tortugas, northeastern and north central Gulf of Mexico, Bermuda, the Bahamas, the Caribbean, Central America and northern Brazil; [2] occur only as strays north of North Carolina,[3] and there is no evidence that fully grown adults inhabit the Atlantic coast of the United States north of the Bahamas.[1] Reported in the eastern Atlantic from the Canary Islands,[9,10] the Gulf of Palermo,[1] Mediterranean, Madeira and Morocco.[12]

Area distribution: Chesapeake Bay at Fisherman's Island, Virginia; [3] Worcester County, Maryland; [4] Delaware; [1] Atlantic City, New Jersey.[5]

Habitat and movements: Adults—occur in schools near shore, over rocky and sandy bottoms, coral reefs,[7,8] and turtlegrass; usually taken at depths less than 5 m, but schools of larger individuals often observed at greater depths.[8]

Larvae—no information.

Juveniles—most frequently taken under patches of *Sargassum*,[1,8] at depths less than 5 m.[8] Optimal salinities 35.4–36.5 ppt; optimal temperatures 23.6–29.0 C.[1]

SPAWNING

Specimens under 20 mm taken throughout the year, indicating that spawning occurs over a large part of year.[1]

EGGS

No information.

EGG DEVELOPMENT

No information.

YOLK-SAC LARVAE

No information.

LARVAE

No information.

JUVENILES

10.4 mm or less and larger.

At 10.4 mm, all dorsal soft rays unbranched; at 13.1 mm soft rays start branching; by 26.4 mm all soft rays branched. At 13.2 mm all anal soft rays unbranched; at 15 mm soft rays start branching; by 21.5 mm all soft rays branched. At 10.5 mm all principal caudal rays formed, 8+8 procurrent rays; at 15 mm branching complete; at 15.4 mm 9+9 procurrent rays. At 10.4 mm, all pectoral rays unbranched, all but first and last 3 segmented; at

Fig. 167. *Kyphosus sectatrix*, Bermuda chub. A. Adult, 195 mm TL. B. Juvenile, 10.5 mm. C. Juvenile, 15.0 mm. D. Juvenile, 18.7 mm. (*A, Böhlke, J. E., and C. C. G. Chaplin, 1968: 408. © Academy of Natural Sciences of Philadelphia. Used with permission of authors and publishers. B, C, Moore, D., 1962: figs. 1, 2. D, Moore, D., 1962: fig. 3a, delineated by Joan Ellis.*)

26.9 mm all segmented; at 52 mm all but first 2 and last 1 branched; 71.5 mm all but first 2 branched and this condition remains in adults. At 10.4 mm all pelvic soft rays segmented and middle 3 branched; at 13.1 mm all branched. At 10.5 mm, scales present on sides of body and caudal peduncle; at 26.4 mm scales cover bases of all fins and the head, except for area around and anterior to nostrils, lips, edge of orbit, and preopercular margin; at 52 mm scales extend two-thirds length of soft dorsal and anal; at 260 mm all fins scaled except spinous dorsal and anal, which are scaled at bases, and pelvic which has scales only along rays. Gill raker number increases slightly from 10–260 mm. At 10.5 mm 10 canines on premaxillary, incisiform teeth on dentary, and teeth present on pterygoid; by 100 mm characteristic adult teeth present.[1]

Pigmentation: At 10–12 mm small dark pigment spots cover much of body and fins except caudal, first 3 dorsal and anal soft rays and distal parts of other soft dorsal and anal rays; top of head, upper lip, and area behind and in front of eye with larger, lighter brownish spots; some with several rows of large dark spots above lateral

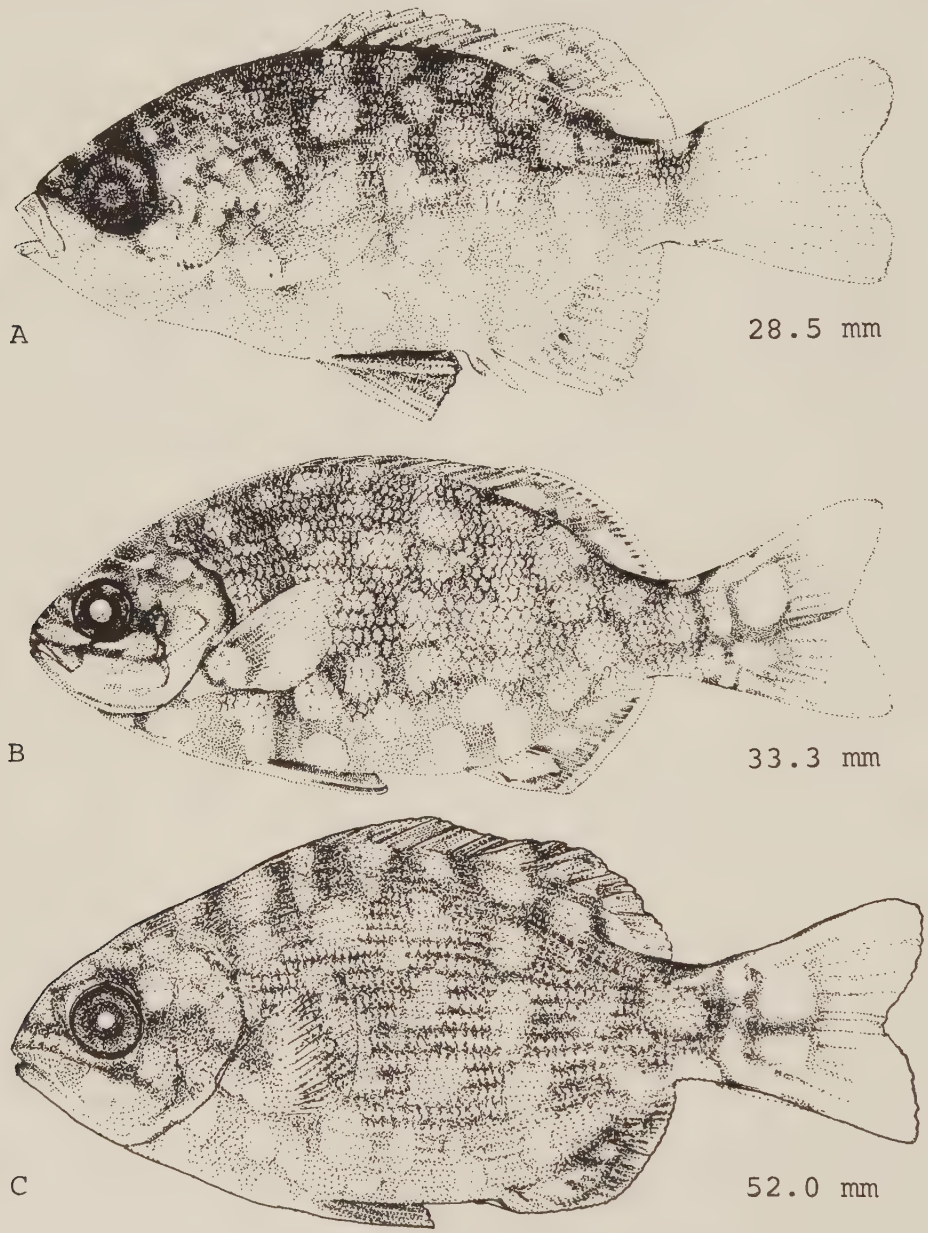

Fig. 168. *Kyphosus sectatrix*, Bermuda chub. A. Juvenile, 28.5 mm. B. Juvenile, 33.3 mm. C. Juvenile, 52.0 mm. (*Moore, D., 1962: fig. 3 B-D, delineated by Joan Ellis.*)

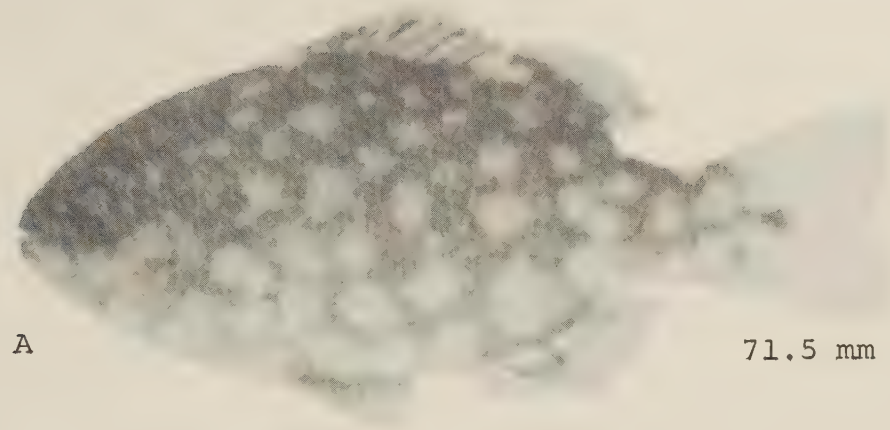

Fig. 169. *Kyphosus sectatrix,* Bermuda chub. A. Juvenile, 71.5 mm. (*Moore, D., 1962: fig. 3e.*)

line or faint brownish bands on sides below dorsal fin. At 12–15 mm first 3 dorsal and anal soft rays have pigment spots, except at tips and pigment on dorsal, anal, and pelvic fins more intense. At 15–16 mm head without large brownish spots; small brownish spots extend along scale rows, most prominent above lateral line; small dark dashes along pectoral rays; small spots in middle of caudal near hypural base. At 18–19 mm sides brownish with light buff patches; head brownish dorsally and buff ventrally; ventral surface buff back to anal spine. At 20–30 mm sides buff with light brownish areas and dark stripes along scale rows above lateral line; first 3 dorsal and anal soft rays usually with pigment. At 30–75 mm whole body dark with light patches, including head, stomach, dorsal and anal fins, and proximal half of caudal. At 75–260 mm sides without spots or light patches; brassy stripes evident along scale rows.[1]

GROWTH

No information.

AGE AND SIZE AT MATURITY

No information.

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Chaetodipterus faber

spadefishes
Ephippidae

FAMILY EPHIPPIDAE

This family is circumtropical in distribution, with a few members ranging into temperate waters. Böhlke and Chaplin (1968) attribute six genera to the Ephippidae, however, its limits are poorly defined, and it may well include additional genera. A single genus and species occurs in the Western Atlantic. It has often been stated that the ephippids share a close relationship to the Chaetodontidae, but this has never actually been sufficiently investigated.

Ephippids are generally schooling fish, feeding on a variety of plants and invertebrates, including, by some reports, tunicates and ctenophores. Leaf and seed pod mimicry has been reported in the juveniles of *Platax* and *Chaetodipterus* and may occur in other genera as well.

Information on early development is unavailable for most species. Ryder (1887) described the eggs and yolk-sac larvae of *Chaetodipterus faber,* however, the identity of these specimens is questionable and generalizations concerning development are not possible.

Chaetodipterus faber (Broussonet), Atlantic spadefish

ADULTS

D. IX,[5,15,17] 21 [17]–23; [5,15,17] A. III, 17 [17]–20; [5] C. 9+8; [20] P. 17–18; [15] V. I, 5; [16] scales 53 [17]–75 [5] in lateral series, lateral line scales 46–49; [15] vertebrae 10+14; [16,20] gill rakers short, 10–13 on lower limb of first arch; [5] branchiostegals 6; gill membranes broadly united to isthmus; [5,16] teeth in jaws moveable,[5] in brush-like bands, outer series slightly enlarged; [4,5] vomer and palatines without teeth.[16,20]

Head 2.7 [17]–3.5,[16] depth 1.1 [5,16]–1.7 [16] in SL; snout 2.2 [17]–2.6,[5,16,17] eye 2.7 [5]–4.2,[16] interorbital 2.6 [5,16]–3,[5] maxillary 3 [5]–3.5,[16] pectoral fin 1.4 [5]–1.7 [17] in head.

Body short, deep, compressed, only a little longer than deep; [4,5] snout short and blunt; mouth small, terminal. Lateral line strongly arched; scales small, ctenoid.[5] Soft dorsal and anal fins densely covered with very fine scales; [16,17] dorsal fin deeply notched, the third spine somewhat produced to at least length of head [5] and with

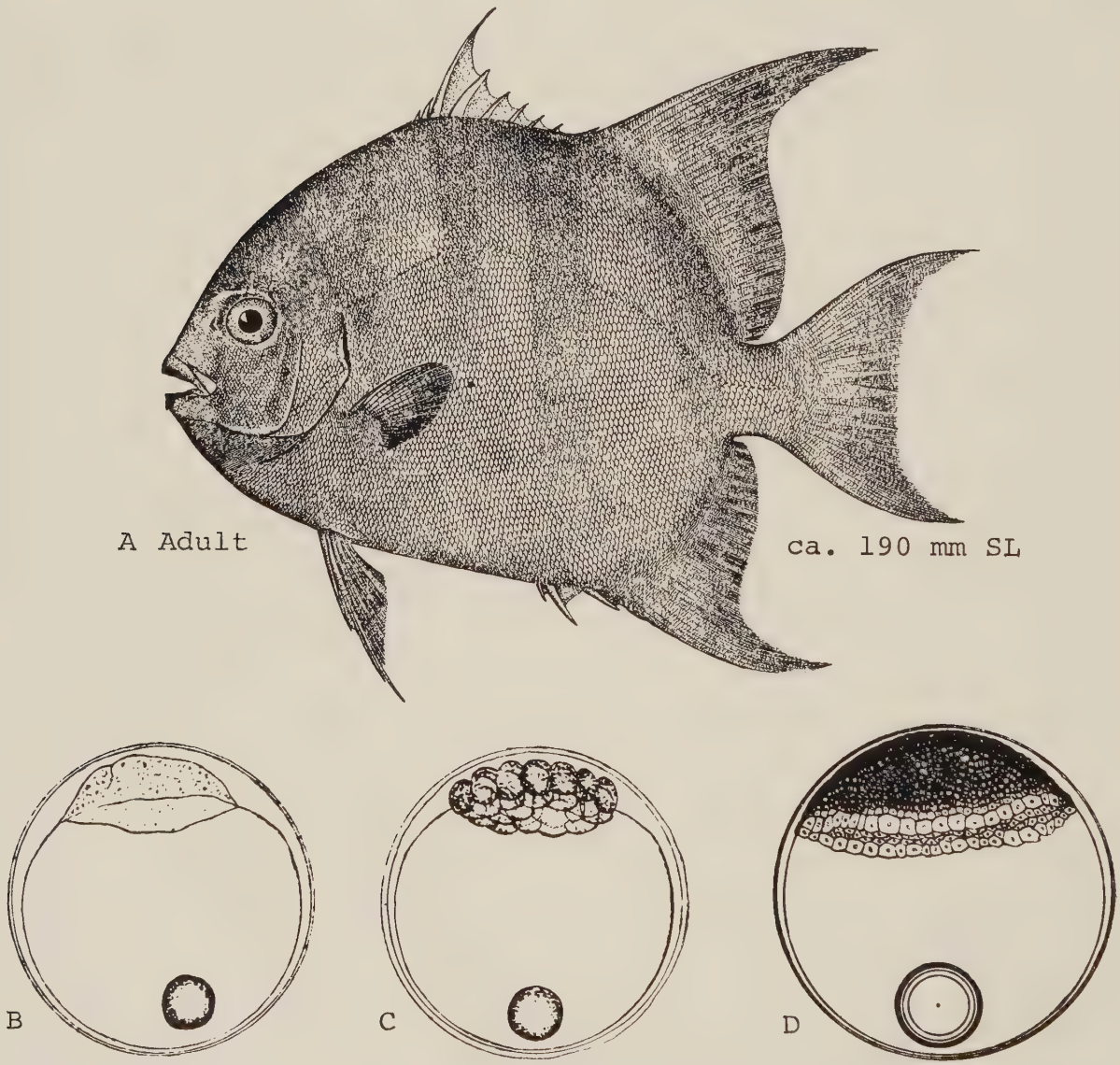


Fig. 170. *Chaetodipterus faber,* Atlantic spadefish. A. Adult, ca. 190 mm SL. B-D. Putative mature eggs showing position of oil globule and development of blastodisc. (*A, Hildebrand, S. F., and W. C. Schroeder, 1928: fig. 183. B-D, Ryder, J. A., 1887: figs. 58, 60, 61.*)

a black membrane posteriorly which exceeds length of spine;[17] anterior soft rays of dorsal and anal quite produced, making fin margins concave;[4] caudal fin broadly concave;[5,17] pelvics with one or more outer ray produced to or beyond anal origin,[5] axillary process well developed.[20] Air bladder bifurcate, with two slender horns posteriorly.[16] Preopercular margin finely serrate.[15]

Pigmentation: Color variable from brown[4] to grayish to greenish and yellowish;[5] chest and abdomen white;[17] sides with 4[5]–6[5,17] dark vertical bands; the first above orbit through eye to throat, the second just behind margin of opercle, the third a narrow half-bar from base of fourth and fifth dorsal spines to or slightly below middle of side, fourth broad from origin of second dorsal to origin of anal, fifth under middle of soft dorsal, sixth at base of caudal;[17] bars fading in large individuals.[4,10]

Maximum size: Reported to reach a length of over 900 mm[5,11,16] although individuals over 600 mm are unusual.[11]

DISTRIBUTION AND ECOLOGY

Range: Cape Cod[4,5,14] to Santos, Brazil, throughout Gulf of Mexico;[14] rare north of Chesapeake Bay.[4,5]

Area distribution: Recorded in lower Chesapeake Bay from Solomons, Md.,[1] and mouth of Potomac River; Cape Charles City, Norfolk, Rappahanock River and lower York River, Virginia.[5] Also recorded from Delaware River estuary[13] and Atlantic City, Sea Isle City, Fortescue, and Barnegat Bay, New Jersey.[19]

Habitat and movements: Adults—tend to congregate in small schools[4,15] around rocky patches, wrecks, and pilings;[6] at night may be found grazing on turtlegrass beds (FDM). Occur in shallow water during the warmer months but rarely found in waters of less than 11 meters during the winter;[1,5,10] at Key West, present the entire year, but most common in the summer; arrives at Beaufort in May and departs to deeper water by beginning of October.[4] Reported from salinities of 4–43.3 ppt and temperatures of 10–33.5 C.[2]

Larvae—taken offshore in bottom towings.[4]

Juveniles—taken in channels and grassy flats,[8] and in shallows over mud and shell,[7] occasionally entering brackish and fresh waters.[18] In tropical and subtropical waters, early juveniles (7–12 mm) are often found during the summer in very shallow water along white sand beaches, where they allow themselves to be rolled back and forth in the wavelets of the quiet inside waters. At this size, they are solid black, and this behavior creates a deceptive resemblance to the infertile seed pods of the red mangrove which litter the shallows at this time. Behavior of this type has not been observed farther north than Florida, the northern limit of the red mangrove.[22]

SPAWNING

Occurs at least as far north as Maryland[12] during spring[9,10] and summer,[4,5,9,10,11,12] probably offshore.[4]

Fecundity: A single female may discharge a million eggs in one season.[3]

Note: *The following descriptions of Eggs, Egg Development and Yolk-Sac Larvae, based on Ryder (1887), are included, as they are the only available information on these stages. However, the identity of these specimens is questionable. Ryder reported the size at hatching as 2.5 mm while the 2.5 mm specimen of Hildebrand and Cable (1933) (where identity is more certain) were considerably more mature, having the yolk sac completely absorbed. Hildebrand and Cable attribute this size discrepancy to shrinkage of their specimen after preservation, however, this seems an excessive difference to ascribe to shrinkage and the possibility that Ryder's specimens were not* Chaetodipterus *should not be ruled out* (GDJ).

EGGS

Buoyant, specific gravity 1.014; diameter a little greater than 1 mm, yolk with a single oil globule.[3]

EGG DEVELOPMENT

Cleavage very rapid, only 1 hour from first cleavage to morula stage; development of marginal cells well marked as the blastodisc spreads; initially oil globule almost exactly opposite center of blastodisc, but occupying a ventromedial position in the yolk sac after embryo formed. After 13 hours, embryo well defined and oil globule covered by periblast; Kupffer's vesicle distinct, and faint pigment cells are scattered over the blastoderm.[3]

Incubation period—24 hours at 27 C.[3]

YOLK-SAC LARVAE

Hatch at 2.5 mm.

At 3 mm (16 hours after hatching), most of the yolk has been absorbed, leaving a large serous space derived from the cleavage cavity. By 3.5 mm (28 hours after hatching), pectoral rays are well developed and embryonic caudal rays are present.[3]

Pigmentation: At 3 mm the pigment spots have become stellate and begin to aggregate in definite groups. By 3.5 mm, traces of a reddish pigment appear on dorsal and lateral portions of abdomen. By 4 mm, pigment cells are aggregated into a distinct band on the mid-caudal region and above the pectoral base.[3]

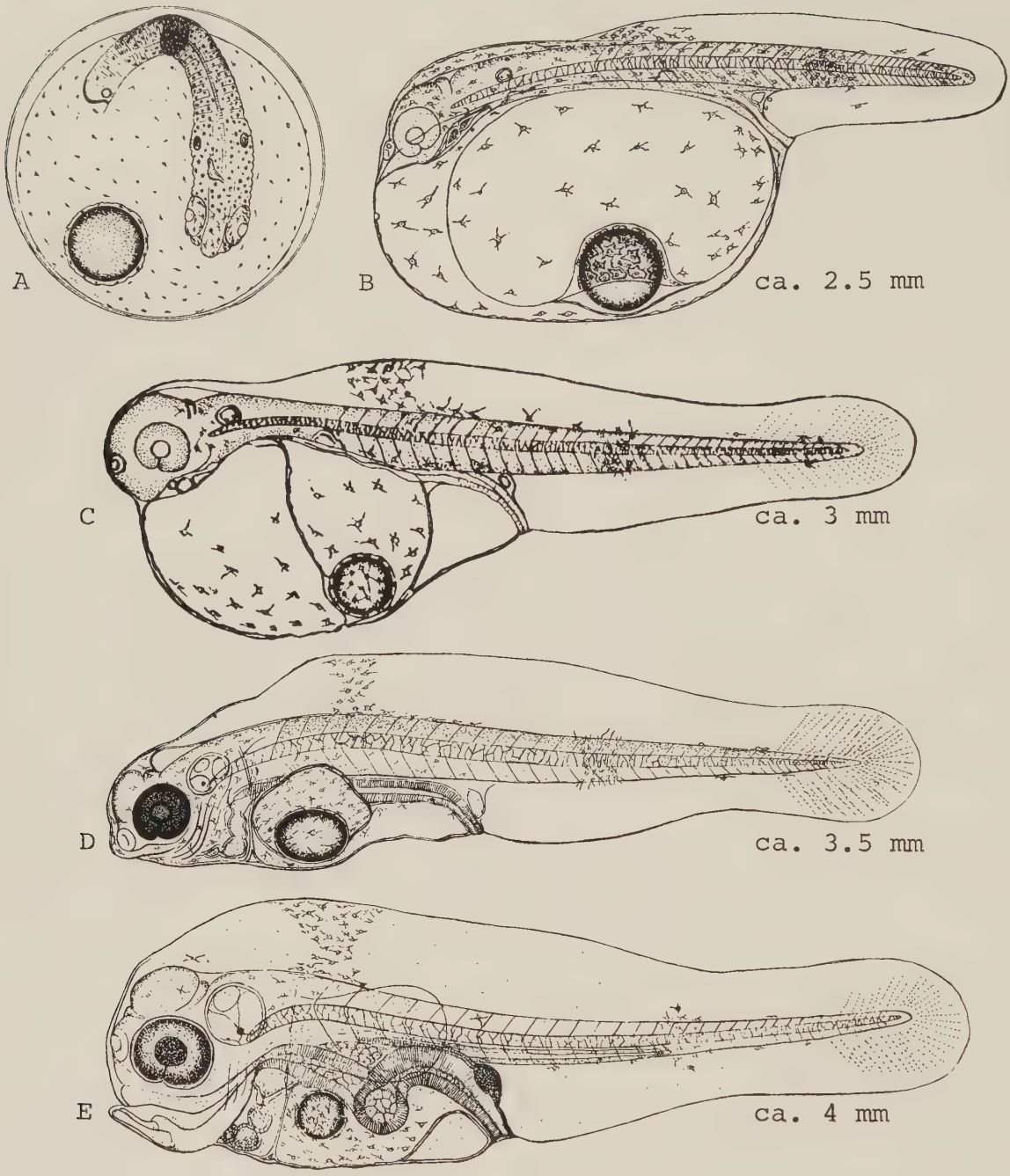


Fig. 171. *Chaetodipterus faber,* Atlantic spadefish. A. Putative egg with embryo, oil globule covered by periblast, pigment cells developed, and Kupffer's vesicle formed. B. Newly hatched yolk-sac larva (putative) ca. 2.5 mm, with oil globule lying at inferior side of yolk, partly invested by cells derived from periblast. C. Putative yolk-sac larva 16 hours after hatching, ca. 3 mm, showing increased cleavage space and aggregation of pigment cells. D. Putative yolk-sac larva 28 hours after hatching, ca. 3.5 mm, showing yolk nearly absorbed. E. Putative yolk-sac larva 53 hours after hatching, ca. 4 mm. (*Ryder, J. A., 1887: figs. 62–66.*)

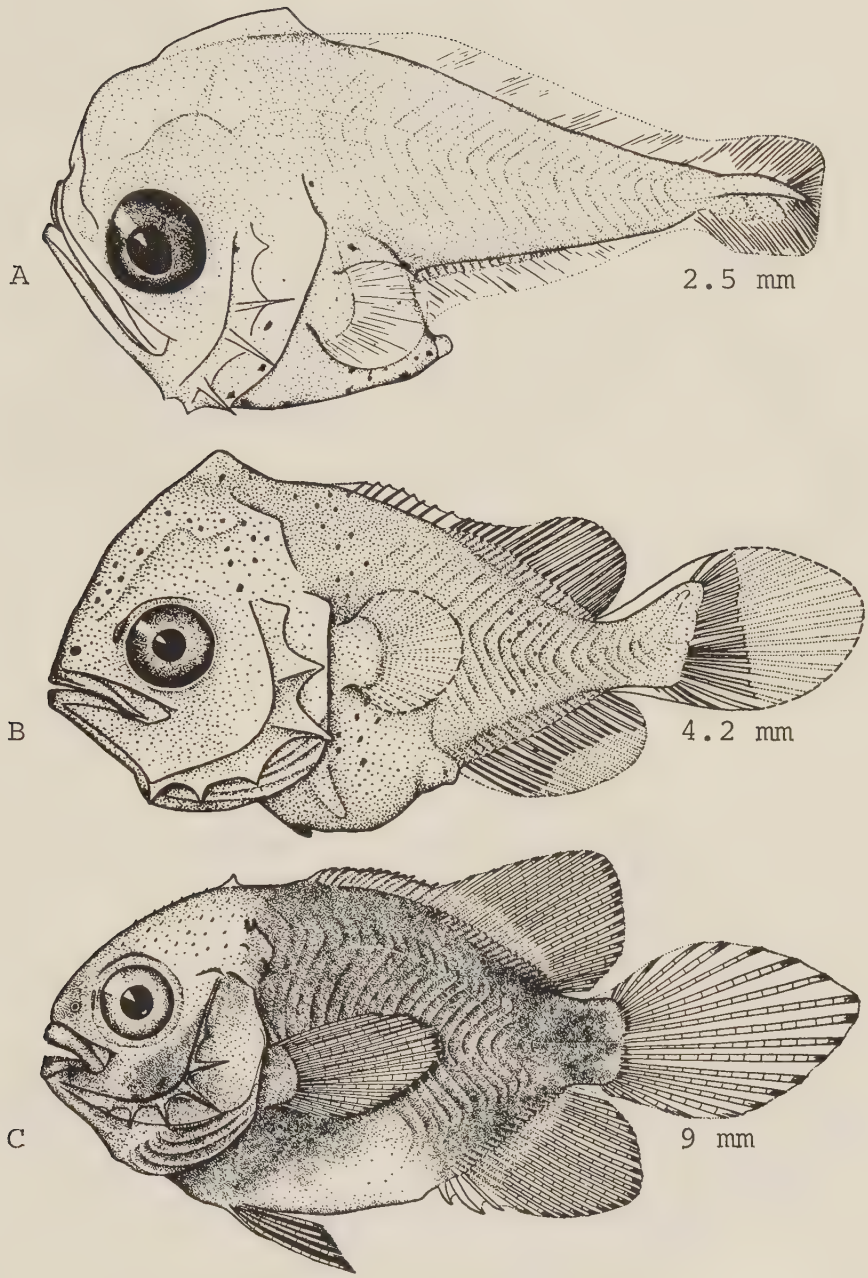


Fig. 172. *Chaetodipterus faber,* Atlantic spadefish. A. Larva, 2.5 mm. B. Larva, 4.2 mm. C. Juvenile, 9 mm. (*Hildebrand, S. F., and L. E. Cable, 1938: figs. 24–26.*)

LARVAE

2.5–9 mm.

Dorsal with 23 and anal with 20 rays visible at 4.2 mm; pectoral fins developed at 2.5 mm, short and broad; pelvic buds absent at 2.5 mm, represented by tufts of skin at 4.2 mm; preopercle with a few prominent spines at 2.5 mm. At 2.5 mm, body deep anteriorly, decreasing greatly just posterior to anus; head deep, with a steep profile, slightly concave just above upper jaw; a sharp dermal crest present on occiput. At 4.2 mm, body remains deep anteriorly, decreasing less sharply posteriorly; dermal crest on occiput row somewhat spine-like. Mouth strongly oblique, maxillary reaching posterior margin of eye at 2.5 mm, just below middle of eye at 4.2 mm. Notochord flexed at 4.2 mm.[4]

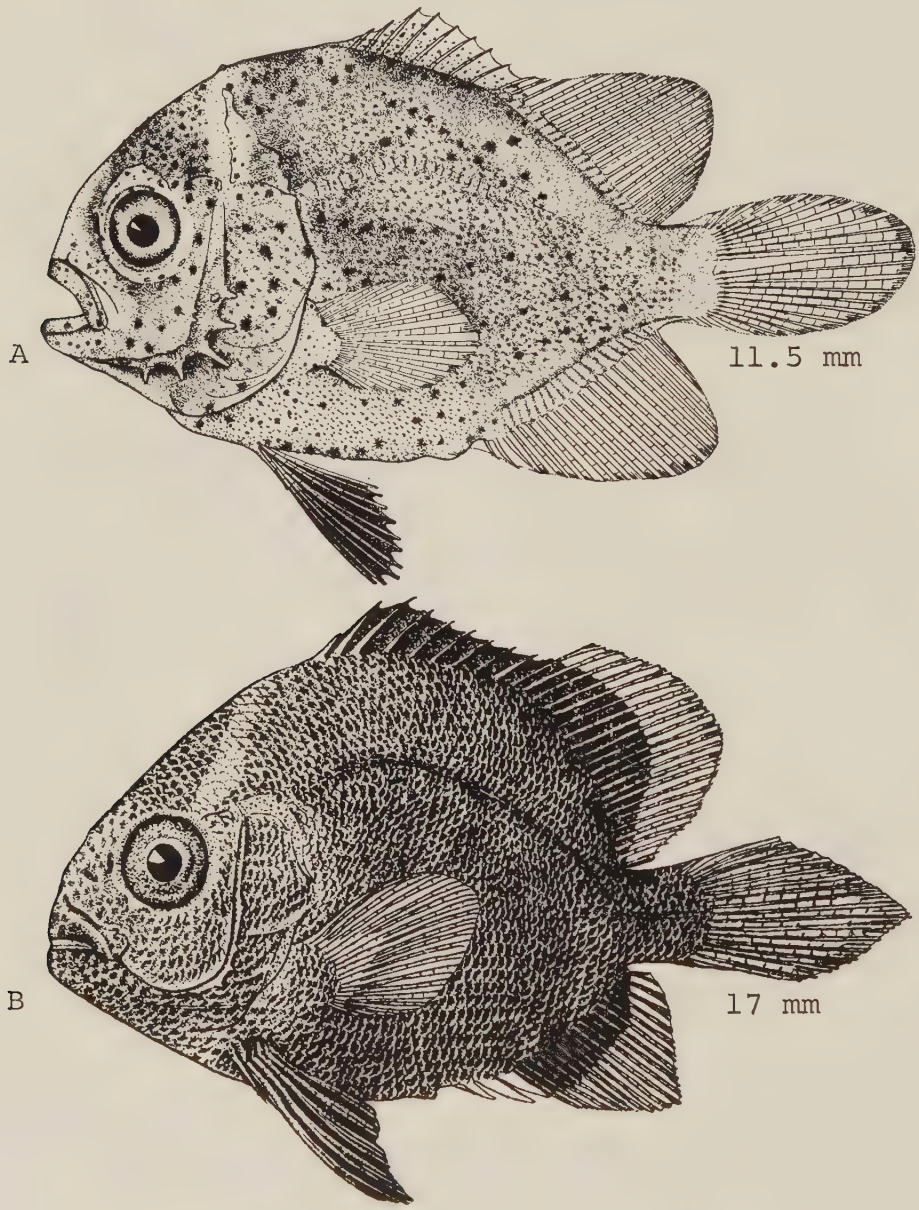
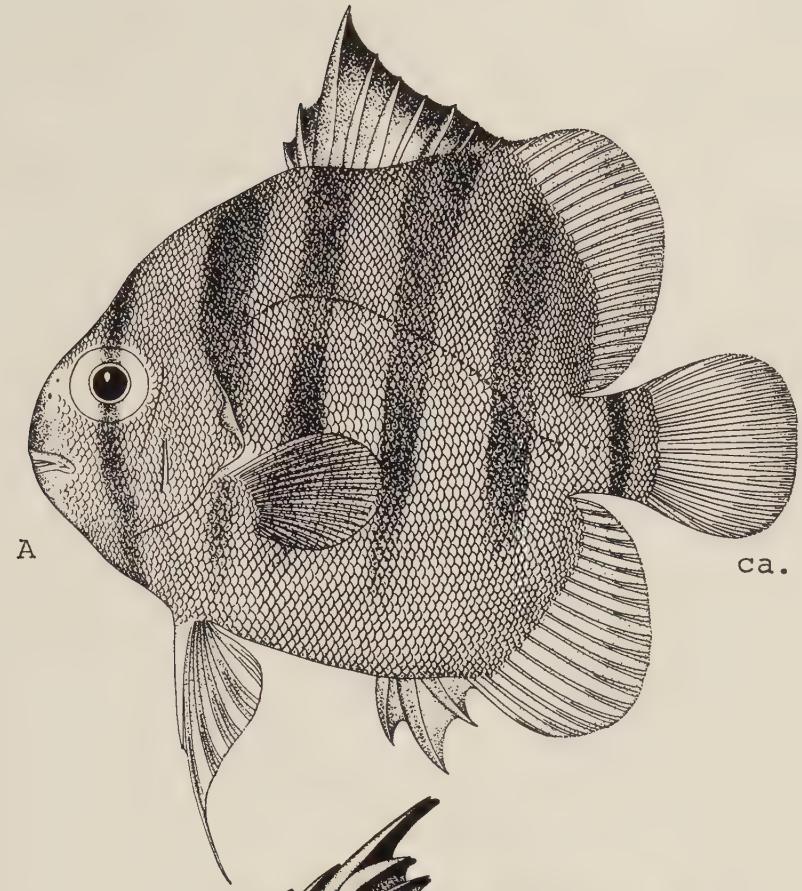


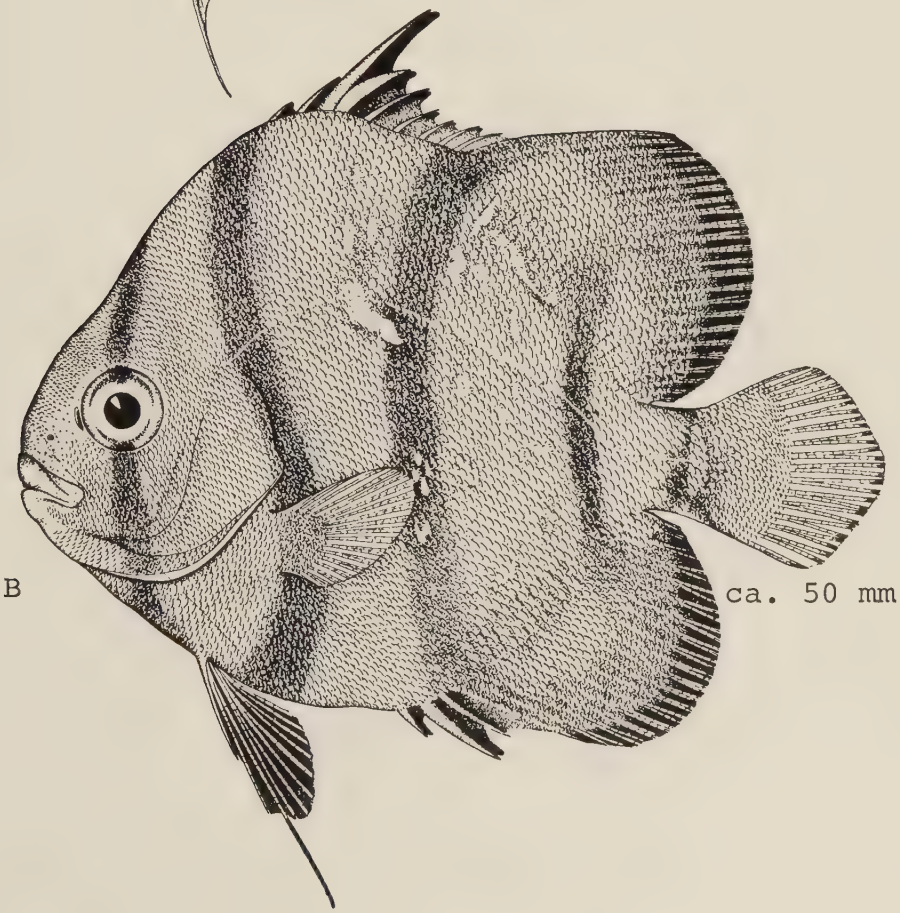
Fig. 173. *Chaetodipterus faber,* Atlantic spadefish. A. Juvenile, 11.5 mm. B. Juvenile, 17 mm. (*Hildebrand, S. F., and L. E. Cable, 1938: figs. 27–28.*)

Fig. 174. *Chaetodipterus faber,* Atlantic spadefish. A. Juvenile, ca. 40 mm. B. Juvenile, ca. 50 mm. (*A, Fowler, H. W., 1945: fig. 284. B, Hildebrand, S. F., and L. E. Cable, 1938: fig. 29.*)



A

ca. 40 mm



B

ca. 50 mm

Pigmentation: At 2.5 mm, body pale gray with a few dark chromatophores on chest, abdomen, and gill covers. At 4.2 mm, very dark; abdomen, head, back, and mid-caudal length with black chromatophores.[4]

JUVENILES

9 mm and larger.

At 15–18 mm lobes of soft dorsal and anal somewhat pointed; by 40–50 mm dorsal spines proportionately as long as in adult, and black membrane present posterior to third spine; at approximately 75 mm (highly variable) the anterior rays of soft dorsal and anal begin to elongate; caudal pointed at 15–18 mm; pelvics to anus by 11 mm, anal origin by 15–18 mm, and by 25–30 mm the first soft ray is produced, reaching about to base of first soft ray of anal. Preopercular spines quite small by 15–18 mm and absent by 40–50 mm. Lateral line well developed by 11 mm. Dermal crest on occiput represented by a small, blunt projection at 11 mm, absent by 15–18 mm. Body shape generally like adult by 25–30 mm. Maxillary scarcely reaching eye at 9 mm; mouth nearly horizontal by 15–18 mm. Teeth present at 9 mm, in brush-like bands, as in adult, by 25–30 mm. Body covered with blunt spine-like plates and head with hair-like spines at 9 mm; at 11 mm scales no longer plate-like and hair-like spines on head minute.[4]

Pigmentation: At 9 mm body generally dark brown, no chromatophores evident; pelvics dark brown, other fins colorless. At 11 mm brownish, with scattered black chromatophores; nape with an indefinite pale crossbar; pelvics black; spinous dorsal and anal with black specks. At 15–18 mm brownish [4] (black in life [9]), with pale bar on nape and preopercle now distinct; snout pale; soft dorsal and anal dark brown about halfway out to margin; [4] caudal colorless.[9] At 20 mm, pale bar on nape fading; 3 dark crossbars now present, one across interorbit through eye to chest, one across nape to behind margin of opercle, and one from base of spinous dorsal to base of anal spines. At 25–30 mm traces of pale bar sometimes remain; a fourth dark crossbar now present from middle of soft dorsal to base of anal; soft dorsal and anal now completely brown except for colorless margin. At 40–50 mm a fifth black bar present on caudal peduncle.[4]

Fig. 175. *Chaetodipterus faber,* Atlantic spadefish. A. Juvenile, 103.5 mm TL. (*Böhlke, J. E., and C. C. G. Chaplin, 1968: 411. © Academy of Natural Sciences of Philadelphia. Used with permission of publisher and authors.*)

GROWTH

Reach a length of 55–100 mm during first summer.[4]

AGE AND SIZE AT MATURITY

Maturity is probably reached after 2 years at a size of approximately 135 mm.[4]

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